MiniScan® EZ

User's Manual

A60-1014-085
Firmware Version **2.18** and above
Manual Version **1.2**

The world's true measure of color
HunterLab

Hunter Associates Laboratory
11491 Sunset Hills Road
Reston, Virginia 20190, USA
www.hunterlab.com

An ISO 9001:2008 Certified Company

Copyrights and Trademarks

This documentation contains proprietary information of Hunter Associates Laboratory, Inc. Its reproduction, in whole or in part, without the express written consent of Hunter Associates Laboratory, Inc. is prohibited.

EasyMatch is a registered trademark of Hunter Associates Laboratory, Inc.

MiniScan is a registered trademark of Hunter Associates Laboratory, Inc.

SpectraFlect is a registered trademark of Labsphere, Inc.

Windows is a registered trademark of Microsoft Corporation in the United States and other countries.

Please keep this user's guide in a safe place. HunterLab must charge a fee for replacement user's guide.

Safety Notes

For your safety when using your MiniScan EZ, you should pay particular attention to the following types of statements in this User's Guide. Each description is shown in its representative typeface.

Notice: General safety instruction that should be observed at all times while operating the instrument.

CAUTION
Specific instruction critical to the type of instrument operation being explained in the area of the manual where the caution appears.

Note: Additional clarification of instructions, not safety-related.

Table of Contents

INTRODUCTION TO YOUR MINISCAN EZ SYSTEM.....1-1

Accessories.....1-3

Options and Sample Devices.....1-5

External Printer.....1-5
Keyboard.....1-5
Bar Code Scanner.....1-6
Standard-A to Mini-A USB Adapter.....1-6
USB mass storage devices..... 1-7
45/0 Fiber Package Adapter.....1-13
Skein Holder.....1-13
45/0 LAV Nose Cone with Lower Glass Assembly or Nose Cone with Lower Polycarbonate Assembly.....1-14
420-nm UV Filter Assembly.....1-14
EasyMatch QC Software.....1-15

The Basics of MiniScan EZ Operation.....1-16

The Button Pad and LCD Display.....1-17
Menus and Prompts.....1-17
About Your Instrument.....1-19

Terminology Used.....1-20

Product Standard.....1-20
Sample.....1-20
Tolerances.....1-20

Installation.....1-22

CONFIGURING OPTIONS AND SETUPS.....2-1

Global Options.....2-2

Language.....2-2
Display Settings ▸.....2-3

Setups Locked? 2-5
Autosave 2-5
Stdz Interval 2-5
Autosearch ▸ 2-7
Date/Time ▸ 2-8

Product Setups 2-10

Setup Name ▸ 2-11
Standard 2-12
Averaging 2-13
Views ▸ 2-14
Standard Values ▸ 2-19
Tolerances ▸ 2-20
Autosearch 2-20

Setup Maintenance 2-22

Reset All Setups ▸ 2-22
Print All Setups ▸ 2-22
Print One Setup ▸ 2-23
Clone All Setups ▸ 2-24

STANDARDIZATION AND READING 3-1

Standardizing 3-1

Standardization Process 3-2
Reading Individual Samples 3-5

Reading with Averaging 3-8

Working with Saved Readings 3-12

Delete All Readings ▸ 3-12
Print All Readings ▸ 3-13
View Saved Readings ▸ 3-13
Filter By Setup ▸ 3-14

LESSONS 4-1

Lesson 1: Showing Multiple Color Scales or Display Types for a Single Sample 4-3

Lesson 2: Matching the MiniScan EZ to a Reference Instrument (The Hitch Standard) 4-10

Lesson 3: Automatically Generating Color Tolerances (CMC)4-15

Lesson 4: Displaying Metamerism Index.....4-20

Lesson 5: Measuring Opacity 4-26

Lesson 6: Searching for the Closest Standard to a Read Sample 4-30

Lesson 7: Using Colorant Strength.....4-40

Lesson 8: Using Shade Numbering.....4-46

SAMPLE PREPARATION AND PRESENTATION 5-1

Selecting Samples.....5-1

Preparing Samples 5-2

Sample Presentation 5-3

Directional Samples 5-4
Non-opaque Samples 5-4
Translucent Samples.....5-5

MAINTAINING AND TESTING MINISCAN EZ 6-1

Recharging/Replacing the Batteries.....6-1

Cleaning the MiniScan EZ.....6-3

Maintaining the Instrument Standards.....6-4

Replacing the Lamp 6-5

Diagnostics 6-6

White Repeatability ▸ 6-6
Green Tile Check ▸ 6-7
Signal Levels ▸ 6-7
Self Test ▸ 6-9

SPECIFICATIONS.....7-1

Operating Conditions.....7-1

Physical Characteristics.....7-2

Conditions of Illumination and Viewing **7-3**

System Power **7-4**

Instrument Performance **7-5**

Regulatory Notice **7-6**

INSTRUMENT REPLACEMENT, REPAIR, PROBLEMS, AND QUESTIONS **8-1**

Warranty **8-1**

Shipping Claims **8-2**

Breakage or Damage 8-2
Shortage 8-3
Incorrect Shipment 8-3

Returns/Repairs **8-5**

Packing and Shipping Instruments for Repair 8-5

When You Need Assistance **8-7**

MEASUREMENT VALUES **9-1**

Absolute Color Scales **9-1**

CIE Tristimulus Values, XYZ 9-1
CIE Chromaticity Coordinates, Yxy 9-1
Opponent Color Scales: Hunter L, a, b, CIE L*a*b*, and CIE L*C*h 9-2

Difference Color Scales **9-6**

dXdYdZ 9-6
dYdxdy 9-6
dLdadb 9-6
dL*da*db* 9-7
dL*dC*dH* 9-7

Absolute Indices **9-8**

457-nm Brightness 9-8
Tint ASTM E313 9-8
Whiteness Index 9-9
Y Brightness 9-9

Yellowness Indices....9-10
Paper Brightness (Z%)....9-11

Difference Indices....9-12

D457B....9-12
dTint....9-12
dWIE....9-12
dY Brightness....9-12
dYIE and dYID....9-12
dZ%....9-13

Other Indices....9-14

dE Total Color Difference....9-14
dC Chromaticity Difference....9-14
dE* Total Color Difference....9-14
dC* Chroma Difference....9-14
Colorant Strength....9-14
dEc and CMC Autotolerancing....9-15
Gray Change....9-17
Gray Stain....9-20
Metamerism Index....9-21
Shade Number....9-21

Opacity....9-25

Appendix A Utility Software....A-1

CHAPTER ONE

Introduction to Your MiniScan EZ System

Notice: Use of this equipment in a manner not specified by the manufacturer may impair the protection afforded by the equipment.

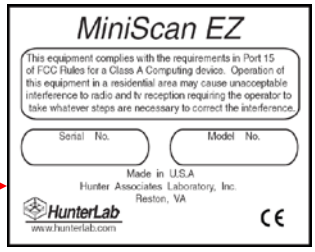
Notice: Take care not to drop the MiniScan EZ. If it is dropped, have it evaluated for damage before operation.

The MiniScan EZ spectrophotometer is a versatile color measurement instrument that can be used on products of virtually any size, and in industries as diverse as paint and textiles. Because of its compact design and portability, MiniScan EZ can be used to measure objects that would be difficult to position at the measurement port of a larger color instrument normally found in a laboratory, and in locations other than a laboratory.

The instrument uses a xenon flash lamp to illuminate the sample. The light reflected from the sample is then separated into its component wavelengths through a dispersion grating. The relative intensities of the light at different wavelengths along the visible spectrum (400-700 nm) are then

analyzed to produce numeric results indicative of the color of the sample. This is an objective means of quantifying what was once considered a subjective aspect of a sample's appearance—its color.

MiniScan EZ is available in four different models based on viewing area and geometry. The label on the bottom of the instrument provides this information, which is outlined below.


MiniScan EZ
This equipment complies with the requirements in Part 15 of FCC Rules for a Class A Computing device. Operation of this equipment in a residential area may cause unacceptable interference to radio and tv reception requiring the operator to take whatever steps are necessary to correct the interference.
Serial No.
Model No.
Made in U.S.A
Hunter Associates Laboratory, Inc.
Reston, VA
HunterLab
www.hunterlab.com
CE

Model	Geometry	Viewing Area
MSEZ-4500L	45°/0°	Large
MSEZ-4500S	45°/0°	Small
MSEZ-4000L	Diffuse/8° (Sphere)	Large
MSEZ-4000S	Diffuse/8° (Sphere)	Small

Accessories

The following accessories are included with the MiniScan EZ and can be found in the provided carrying case:

- Dust cover - screws on over the sample port to protect the instrument's optics when it is not in use.

- Calibration cylinder - houses the NIST traceable white calibrated tile that is placed at the sample port during standardization to set the top of scale, the black glass or light trap that is placed at the sample port during standardization to set the zero, and the green check tile that is used to assess long-term instrument performance during the green tile test.

- Rechargeable batteries - a set of 6 rechargeable AA batteries and a charger (with 110V plug and 220V adapter) are provided for continuing use of the MiniScan EZ.

- USB cable for connecting the MiniScan EZ to a computer.
- Certificate of traceability for the standard white tile.
- Tile data sheet - provides NIST-traceable calibrated values for the standard white tile and values read at factory for the green tile.

- MiniScan EZ User's Guide.
- Utility software and Diagnostics CD (see Appendix A for installation and operation instructions).

Options and Sample Devices

There are many options and devices available for positioning samples at the measurement port of the MiniScan EZ and for making the instrument easier to use. Any or all of the following options and sample devices may be purchased for use with your MiniScan EZ. HunterLab part numbers are provided for your convenience in ordering.

External Printer (HL#A13-1014-259)

The external thermal printer connects to the MiniScan EZ's USB port via Standard-A to Mini-A adapter (HL#A21-1013-859) and prints measurement data or product setup parameters on request. The communications cable supplied with the printer must be used to connect the printer to the MiniScan EZ. More information on the external printer is provided in its separate User's Manual.

The printer is automatically detected by the MiniScan EZ once connected.

Keyboard (HL#A13-1014-294)

The optional flexible keyboard connects to the MiniScan EZ's USB port via Standard-A to Mini-A adapter (A21-1013-859) to allow easy entry of any alphanumeric information (such as setup names) required.

The up, down, left, and right arrow keys on the keyboard correspond to the same buttons on the MiniScan EZ button pad. The Enter key on the keyboard emulates the center (Go) button on the MiniScan EZ's button pad. Numbers and letters may be typed on the keyboard as usual.

The keyboard is automatically detected by the MiniScan EZ once connected.

Bar Code Scanner (HL#A13-1014-254)

The optional bar code scanner connects to the MiniScan EZ's USB port via Standard-A to Mini-A adapter (HL#A21-1013-859) to allow scanning of a bar code for the ID tag of a reading after the reading is made.

The bar code reader is automatically detected by the MiniScan EZ once connected.

Standard-A to Mini-A USB Adapter (HL#A21-1013-859)

The optional Standard-A to Mini-A USB adapter allows USB devices—such as printers, keyboards, and the bar code scanner—that normally connect to Standard-A USB ports like those on computers, to connect to the MiniScan EZ's Mini-A USB port. It also allows the standard MiniScan EZ USB cable to be used to connect two MiniScan EZ instruments together.

USB mass storage devices:

MiniScan EZ instruments can interface directly with thumb drives and other USB mass storage devices commonly available for use on personal computers. The instrument is designed to be compatible with most devices formatted to use the FAT16 file system which provides up to 2 GB of disk space. Mass storage devices can be connected to the USB Mini-A receptacle through the use of a USB Mini-A plug to USB Standard A- receptacle adapter (**HunterLab Part Number A21-1013-859 or equivalent**).
These are some of the thumb drives found to be compatible with the MiniScan EZ firmware:

Imation 2GB Pocket Flash Drive
Verbatim 1GB Store 'n' Go USB Drive
Edge 1GB diskGO Flash Drive
Kingston 2GB DataTraveler 100

Using a thumb drive you can transfer and/or archive product setups and measurements. The reflectance of the instrument's white standard can also be updated using files provided by HunterLab.

Operation:

Attach the thumb drive to the MiniScan EZ using the appropriate adapter cable, the instrument will double-beep to acknowledge the connection then it will start a short session to query information from the drive during which its status indicator light should blink. If successful, the MiniScan EZ will double-beep again. If, for whatever reason, communications fail a single beep would be emitted. In this case, you can try disconnecting and reconnecting the thumb drive.

Caution: never disconnect the thumb drive from the MiniScan EZ until its status indicator light has stopped blinking. Otherwise, data loss might occur.

Thumb drive information:

If a thumb drive has been inserted and is recognized, the MiniScan EZ will beep 2 times. Pressing the right arrow key from the MAIN MENU displays a THUMB DRIVE INFORMATION screen showing certain characteristics of the drive.

The values may differ depending on the type of drive attached, but on a properly identified drive all the fields should have non-zero values.

Archiving product setups:

From the MAIN MENU, press the up/down arrow keys until SETUP MAINTENANCE is selected then press the center button. Select the function PRINT ALL SETUPS and press the right arrow keys . The instrument will immediately start writing data to disk while indicating how many product setups have been copied so far.

Pressing the left arrow key (labeled CANCEL) will stop the copying process and close the file. Data copied thus far will be retained.

The file containing the product setups, named "PRODUCTS.MS3", is created in the root folder.

Archiving measurements:

From the MAIN MENU, press the up/down arrow keys until SAVED READINGS is selected then press the center button. Select the function PRINT ALL READINGS and press the right arrow key. The instrument will immediately start writing data to disk while indicating how many measurements have been copied so far.

Pressing the left arrow key (labeled CANCEL) will stop the copying process and close the file. Data copied thus far will be retained.

The file containing the measurements, named "DATALOG.MS3", is created in the root folder.

File Import Menu:

From the MAIN MENU access the THUMB DRIVE INFORMATION screen by pressing the right arrow key. Pressing the right arrow key (now labeled IMPORT) again, results in the FILE IMPORT MENU.

Caution: Do not attempt to import files not created by a MiniScan EZ instrument.

Transferring product setups:

To transfer product setups to the instrument a file named "PRODUCTS.MS3" must exist in the root folder of the thumb drive, then from the FILE IMPORT MENU select the IMPORT SETUPS function and press the right arrow key. The MiniScan EZ will display the progress of the import and beep twice once the transfer is complete.

Transferring measurements:

To transfer readings to the instrument's datalog a file named "DATALOG.MS3" must exist in the root folder of the thumb drive, then from the FILE IMPORT MENU select the IMPORT READINGS function and press the right arrow key. The MiniScan EZ will display the progress of the import and beep twice once the transfer is complete.

White tile replacement or recalibration:

Assigned reflectance values for your instrument's white tile can be provided by HunterLab in a file named "WHITE.MS3". This file must be placed in the root folder of the thumb drive. To update the instrument select the IMPORT WHITE TILE function from the FILE IMPORT MENU and press the right arrow key.

45/0 Fiber Package Adapter (HL#C02-1002-030)

This option provides a special nose cone assembly and three removable adapters for measuring 6-inch (152-mm), 10-inch (254-mm), and 12-inch (305-mm) cylindrical fiber or yarn package diameters. To use the assembly, snap the appropriate port adapter onto the nose cone of the MiniScan EZ. Position the port adapter over the cylindrical fiber or yarn package and proceed with measurements. Take care to position the MiniScan EZ so that it will not move during readings. Averaging is recommended when measuring fibers or yarns with large diameters.

Skein Holder (HL# 02-7396-00)

The skein holder is available only for 45°/0° MiniScan EZ models.

This is a device for measuring yarn skeins. Wind the yarn around the skein holder in multiple taut layers until it is effectively opaque and is as flat as possible. Secure it in place with the detachable arms on the sides of the skein holder. Place the skein holder on a flat surface or the calibration tile holder and press the MiniScan EZ's sample port flat against the sample. Make several measurements of the skein, rotating the

holder 90° between measurements and averaging the readings for the final result.

45/0 LAV Nose Cone with Lower Glass Assembly (HL#A02-1014-374) or Nose Cone with Lower Polycarbonate Assembly (HL# D02-1014-427)

This option includes a special nose cone with a removable glass or plastic port cover assembly. The nose cone (black) portion is intended for permanent use on the instrument and should not be removed. Replacement cover assemblies (the lower portion of the device) are available from HunterLab. The assembly is sealed, but is not to be considered waterproof.

The nose cone/lower cover is generally in place when the MiniScan EZ is shipped from the factory. However, if installation is required, place the assembly over the instrument port and secure it using three Phillips-head screws. If the glass or plastic cover is to be replaced, remove the three machine screws with lock washers, replace the window and the O-ring, and secure it using the machine screws.

420-nm UV Filter Assembly (HL# D02-1014-436)

This option provides a 420-nm UV filter in a replaceable assembly for the 45/0

LAV MiniScan EZ. The UV filter may be replaced when necessary, however, the instrument is not to be used without the UV filter assembly in place.

Note: The special nose cone required for use of this part is not included, but may be purchased separately.

To install the UV filter assembly, secure it to the instrument nose cone using three 4-40 pan-head screws with split-lock washers.

Replacement UV filter assemblies are available from HunterLab and are marked "UV" to differentiate them from cover glass assemblies. To replace the UV filter assembly, remove the screws and lift the assembly off the nose cone. Place the new UV filter assembly on the nose cone and replace the screws.

EasyMatch QC Software (HL#EZMQC-MS)

EasyMatch QC is a Windows-based computer program that performs numerical calculations on data measured by the MiniScan EZ, stores sample measurements, and provides graphical representations of data. Measurements may be made and stored in the MiniScan EZ memory and then uploaded into the software, or the MiniScan EZ may be directly controlled by the software. Instructions for EasyMatch QC are provided in its separate User's Manual.

The Basics of MiniScan EZ Operation

Commands are given to the MiniScan EZ using the five buttons on its button pad, instructional prompts and measurements and are displayed on the 160 x 160 pixel liquid crystal display (LCD) screen.

When an item is to be measured using the MiniScan EZ, the area of interest should be placed flush at the sample port with the side of the sample to be measured toward the instrument. The sample must completely cover the sample port.

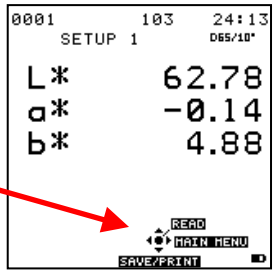
When the read command is given using the button pad, the xenon flash lamp illuminates the sample, and the light reflected back to the detector by the sample is evaluated. The calculated measurement is then shown on the LCD.

Up to 800 readings and 100 product setups may be stored in the MiniScan EZ's memory.

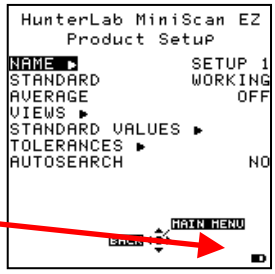
The Button Pad and LCD Display

The five buttons on the button pad can be loosely defined as the left, right, up, and down buttons, with the circular "Go" (lightning bolt) button housed in the center of the arrows. In actuality, however, these buttons perform slightly different functions depending on the current operation. Consult the miniature

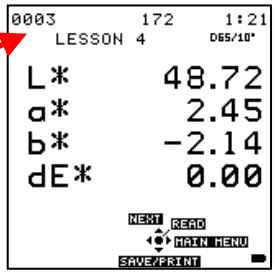
map of the button pad shown at the bottom of the LCD display for the relevant definitions of the buttons at any particular time.



In addition to operational prompts and the button pad map, the LCD display also contains a battery power indicator in the lower right corner of the screen. As available battery power decreases, pixels are removed from the interior of the battery indicator until only the outline remains, indicating battery power will run out soon.



Across the top of each measurement screen are numbers indicating (left to right) the datalog number for this reading if it was saved to the MiniScan EZ's memory, the lamp flash count since the batteries were last replaced, and the number of hours and minutes since the instrument was last standardized.



Menus and Prompts

All MiniScan EZ functions may be accessed through its main menu. The main menu commands lead to prompts (such as for standardization and reading), setup screens (for product setup and global options), or an additional menu (such as the Diagnostics, Saved Readings, and Setup Maintenance choices), depending on the function requested.

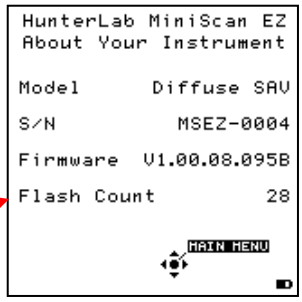
When Return is shown as an available button command on the main menu

screen, you may choose Return to go back to the last screen used before the instrument shut down.

When Off is shown as an available button command on the main menu screen, you may choose Off to immediately turn the instrument off.

About Your Instrument

Information specific to your instrument may be viewed on the About Your Instrument screen, which can be obtained by choosing About from the main menu. Your instrument model, serial number, firmware version, and total flash count for this instrument lamp are displayed.



More details on MiniScan EZ operation are given in Chapters 2 through 4.

Terminology Used

Throughout this user's guide and within the MiniScan EZ's firmware, several terms will be used repeatedly. These terms are defined below.

Product Standard

A product standard (or "standard") is an object that represents the ideal target color for the product. This object is the one to which others will be compared and deemed acceptable or unacceptable. The product standard may either be a physical item that you measure using the MiniScan EZ or a set of color values that you enter into the MiniScan EZ's memory.

Sample

A sample is an object that will be measured with the MiniScan EZ and compared to the product standard. The color of the sample is generally similar to the color of the product standard.

Tolerances

Tolerances are limits that indicate how different a sample can be from the product standard and still be acceptable. Positive and negative tolerances may be set for each color scale and index parameter chosen for display. Then, the MiniScan EZ can show a pass or fail indicator after a sample is read. Samples that differ from the standard by no more than the entered tolerance are said to pass. Samples that exceed the tolerance for one or more parameter are said to fail.

Installation

Before operating the MiniScan EZ, you need only install the batteries. You may also wish to connect it to a computer or to an optional component, such as a printer. Instructions are provided below.

1. Unpack the carrying case and remove wrappings and cable ties. Inspect for damage and notify the carrier and HunterLab immediately if any is discovered. Save the packing materials in case it becomes necessary to return the instrument to the factory.

2. Open the battery compartment on the bottom of the MiniScan EZ.

3. Install the 6 AA batteries, observing the positive (+) and negative (-) polarity guides inside the battery compartment.

Notice: The MiniScan EZ can use six standard AA alkaline batteries or six rechargeable AA NiMH batteries. Do not mix battery types in the instrument. To recharge the NiMH batteries, remove them from the instrument and recharge them using the supplied charger.

4. Close the battery compartment.

5. If the instrument is to be used connected to a computer, printer, or other USB device, plug the hexagonal

(Mini-A) end of the USB cable into the USB port on the MiniScan EZ. Some device cables may require use of a Standard-A to Mini-A adapter.

6. Plug the flat end of the USB cable into the appropriate USB port on the computer or device. If you are connecting to a computer, Windows' plug and play feature should automatically find and install the MiniScan EZ. Let it do so until the "Found new hardware" message disappears. Other devices, such as the printer, bar code reader, and keyboard, are automatically detected by the MiniScan EZ.

7. Turn the MiniScan EZ on by pressing the center (Go) button on the button pad.

CHAPTER TWO

Configuring Options and Setups

Before using the MiniScan EZ to make measurements, you will want to configure the instrument's various options, such as the language, screen angle, and the date and time.

You will also likely wish to configure one or more product setups. A product setup is a set of operating parameters that describe the operation of the MiniScan EZ for a specific product. Up to 100 setups may be stored in the instrument's memory. The parameters that must be defined for each product include the color scale for display, target color values for the product, and the acceptable tolerances applied to the standard values. Each product setup is saved in the MiniScan EZ memory with a setup number and name.

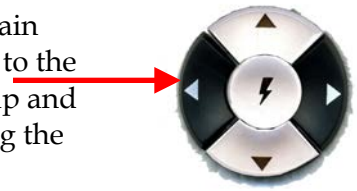
The instrument options and product setups are retained in the MiniScan EZ's memory even when the instrument is turned off.

You may also perform maintenance on your product setups, such as resetting or printing them.

This chapter describes how to configure and maintain the instrument options and product setups.

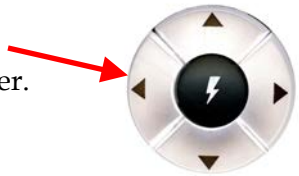
Global Options

Global Options is selected from the main menu by moving the cursor highlight to the "Global Options" position using the up and down arrow buttons and then pressing the center (Go) button.



The Global Options screen appears.

Configure each parameter by moving the cursor highlight to its position using the up and down arrow buttons. When the desired parameter is highlighted, press the left or right arrow button to scroll through the available choices for the parameter. When the appropriate choice is displayed, stop scrolling. You may then move on to configure more options in the same manner.



When all options are as desired, press the center (Main Menu) button to accept the settings and return to the main menu.

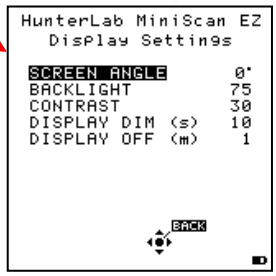
The global options that may be configured are as follows:

Language

MiniScan EZ can display screens and prompts in English, French, German, Italian, and Spanish.

Display Settings ▸

When Display Settings is highlighted and the right arrow button is pressed, a submenu appears. In this submenu, you may set the following parameters:

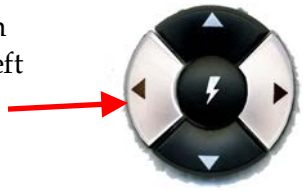


- **Screen angle:** You may rotate the text on the MiniScan EZ screen so that it may be easily read from any side of the instrument. 0° keeps the text in its normal orientation (right-side up when the handle is toward the user). 90° rotates the text so it can be read from the left side of the instrument. This may be the preferred angle if you are right-handed. 180° flips the text upside down. 270° rotates the text so it can be read from the right side of the instrument. This may be the preferred angle if you are left-handed. Please note that the functions of the buttons also rotate when the screen text rotates (i.e., what was previously the up arrow will become the down arrow if you flip the text upside down).

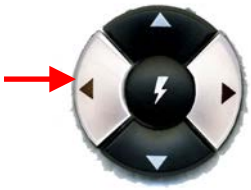
  Each press of the right arrow button increases the displayed value 90°.

- **Backlight:** Press the right arrow button to increase the brightness of the LCD's backlight or the left arrow button to decrease the brightness. Values between 0 and 100 may be selected in increments of 5.

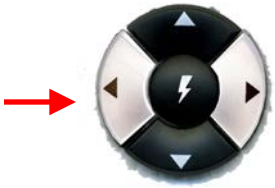
- **Contrast:** Press the right arrow button to increase the LCD's contrast or the left arrow button to decrease the contrast. Values between 0 and 100 may be selected in increments of 2.



- **Display Dim:** Press the right arrow button to increase the time that must elapse (in seconds) after the last button press before the LCD backlight automatically dims. Press the left arrow button to decrease that time. Values between 10 and 50 seconds may be selected in increments of 10. When the backlight dims, the display may still be read, and the press of any button on the button pad causes the backlight to turn back on.



- **Display Off:** Press the right arrow button to increase the time that must elapse (in minutes) after the last button press before the MiniScan EZ's LCD automatically turns itself off. Press the left arrow button to decrease that time. Values between 1 and 4 minutes may be selected in increments of 1. When the display turns off, it may no longer be read, but the press of any button on the button pad causes the display to turn back on.



Note: *The MiniScan EZ will turn off entirely once 5 minutes elapse since the last button press.*

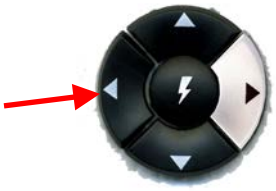
Press Back (the center button) to return to the Global Options screen.

Setups Locked?

Choose YES if you wish to lock your product setups so that changes cannot be made to them. Choose NO if you wish changes to the product setups to be allowed. Each press of the right arrow button toggles between YES and NO.

Autosave

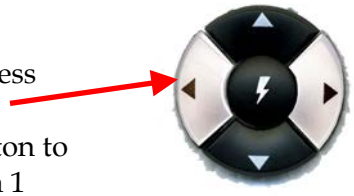
Choose YES if you wish each measurement to be automatically saved to the instrument's datalog as it is made. Choose NO if you wish to save measurements manually, only on demand. Each press of the right arrow button toggles between YES and NO.



Note: When Autosave is used in conjunction with averaging, individual readings are not automatically stored. The user may manually store individual readings.

Stdz Interval

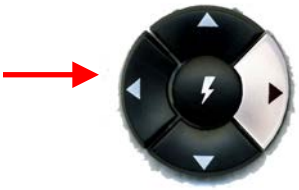
Indicate the amount of time that must elapse (in hours) after the last standardization before the instrument prompts you to standardize again. Press the right arrow button to increase the number of hours or the left arrow button to decrease the number. Values between 1 and 16 may be selected in increments of 1. Selecting 4 is suggested. The choice of OFF is also available (disabling prompting for standardization), but its use is not recommended.



Autosearch ▸

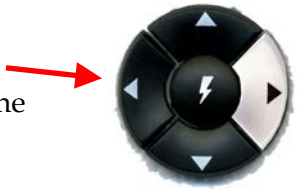
One of the features of the MiniScan EZ is that it allows you to automatically find the closest physical, numeric, or hitch standard stored in the instrument's memory to a sample read.

When Autosearch is highlighted and the right arrow button is pressed, a submenu appears. In this submenu, may set the following parameters:



- **Color Diff:** If you do not wish to use the autosearch feature, set this parameter to (...). If you do wish to use this feature, select the color difference index with which the sample/standard comparison will be made when looking for the closest standard. The choices are dE, dE*, and dEcmc. This index and the illuminant/observer set in each product setup searched will be used for the comparison.

  Each press of the right arrow button changes the color difference index to the next one available.



- **Average:** If you do not wish to average measurements used in autosearching, set this parameter to OFF. If you do wish to use this feature, select the number of readings of each sample you wish to make and average before the comparison to

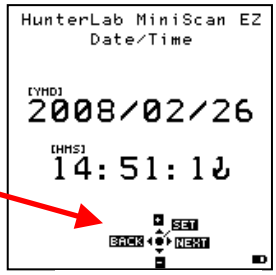
available standards is made. Press the right arrow button to increase the number of readings or the left arrow button to decrease the number. Values between 2 and 20 may be selected in increments of 1.

Press Back (the center button) to return to the Global Options screen.

Date/Time ▸

When Date/Time is highlighted and the right arrow button is pressed, a submenu appears. In this submenu, you may set the current date and time.

Refer to the button pad map at the bottom of the screen.



Press Next each time you wish to move to another parameter to set. Year is set first, then month, then day, followed by the hour and minutes. (You may not set seconds.)

Press + to increase the value of the current parameter or - to decrease it.

Press Set to accept the entered date and time and leave the Date/Time screen.

Press Back to discard the entered date and time and leave the Date/Time screen.

Product Setups

Product Setup is selected from the main menu by moving the cursor highlight to the Product Setup position using the up and down arrow buttons and then pressing the center (Go) button.

The Product Setup screen appears. On this screen, you can choose to select the product setup from a list (Yes) or configure the last setup used (No).

If Yes is chosen, the Select setup to configure screen is shown. Move the cursor highlight to the position of the setup you wish to configure using the up and down arrow buttons or by scrolling through the pages using the right arrow button (Page). Then press the center (Go) button to select it.

The screen that allows you to configure the setup selected (or the last setup used if you chose not to select a setup) appears next.

Configure each desired parameter by moving the cursor highlight to its position using the up and down arrow buttons. When the parameter is highlighted, press the right arrow button to scroll through the available choices for the parameter. When the choice desired is displayed, stop scrolling. You may then move on to configure more parameters in the same manner, if desired.

When all parameters are as desired, press the center (Main Menu) button to accept the settings and return to the main menu or left arrow (Back) to select another setup to configure.

The product setup parameters that may be configured are as follows:

Setup Name ▸

Press the right arrow button to obtain the Product Name screen on which you may enter any descriptive name for the product setup. Up to 15 characters may be entered using all the letters and numbers, as well as the space character.

As shown on the button pad map at the bottom of the screen, use the up and down arrow buttons to scroll up (+) and down (-) through the list of available characters. Press the center button to add a space character. Press the right arrow button to move to the next character in the name. Press the left arrow button when the entire name has been entered.

Standard

Four types of standards are available for selection depending on the measurements you wish to make and the data you wish to see.

Choose **Working** when you wish to read a number of different standards and samples in a single measurement session. A working standard is measured immediately prior to measuring its corresponding samples. Its measurement values will be overwritten the next time you read a standard using this product setup.

Choose **Physical** when an actual product specimen is available that represents the target color to which samples will be compared on a regular basis. A physical standard is measured and stored in the product setup for as long as desired.

Choose **Numeric** when an actual product specimen does not exist for measurement, but the target color values are known from previous measurements. The color values for a numeric standard are entered and stored in the product setup for as long as desired.

Choose **Hitch** when you wish to alter the readings made on the MiniScan EZ to better correlate to another color measurement instrument. A specific

standard with known color values from the other (reference) instrument will then be read with the MiniScan EZ and that reading manually adjusted within the product setup to match the reference instrument. The modified standard is stored in the product setup for as long as desired.

Press the right arrow button to move through the list of available standard types.

Average

Select OFF if you wish to make only one reading of each standard and sample. If you would instead like to average several readings into a single measurement, indicate the number of readings to be averaged, up to 20.

Press the right arrow button to move through the list of available choices.

Views ▸

The settings made under Views indicate what will be shown on the MiniScan EZ's LCD screen after a measurement is made.

Press the right arrow button to obtain the Data Views screen.

Up to eight different views may be displayed for each measurement made with the MiniScan EZ.

Use the up and down arrow buttons to highlight the desired view number. Then press the right arrow button to obtain the Data View screen for that view.

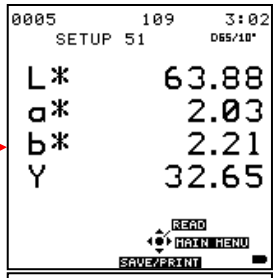
The parameters that may be set are as follows:

- **View:** Use the up and down arrow buttons to move to the View parameter, then toggle between Enabled (view on) and Disabled (view off) using the right arrow button. View 1 is always automatically enabled and may not be disabled.

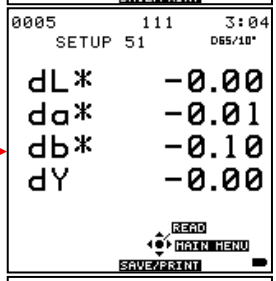
- **Display:** Use the down arrow button to move down to the Display parameter, then scroll through your choices using the right arrow button.

Your display choices are as follows:

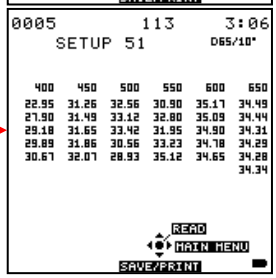
- **Absolute**, which causes raw color scale values (such as L, a, and b) to be displayed for the most recent standard or sample read.



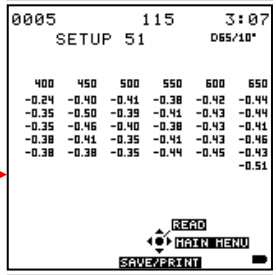
- **Difference,** which causes the most recent sample read to be compared to the standard and the difference in color between them (such as dL, da, db) to be displayed.



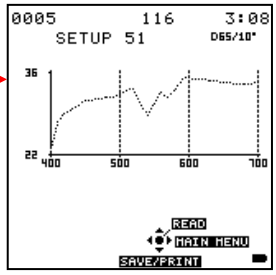
- **Spectral Data**, which causes the raw reflectance values for each wavelength read by the instrument to be displayed for the most recent standard or sample.



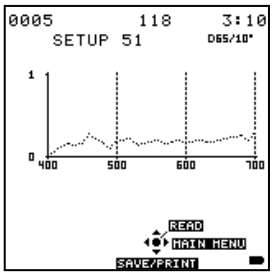
- **Spectral Difference**, which causes the difference between the standard and the most recent sample read to be displayed in raw reflectance values for each wavelength read by the instrument.



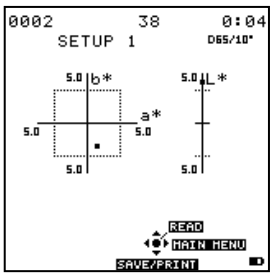
- **Spectral Plot**, which causes the raw reflectance values for each wavelength read by the instrument to be plotted for the most recent standard or sample.



- **Diff Plot**, which causes the difference between the standard and the most recent sample read to be plotted in raw reflectance values for each wavelength read by the instrument.



- **Color Plot**, which displays the sample's location in color space relative to the standard, which is plotted in the center of the a-b and L plots.



- **Ill/Obs:** Choose the illuminant/ observer combination under which color values will be calculated. Use the down arrow button to move down to the Ill/Obs parameter, then scroll through your choices using the right arrow button.

The available choices are A/2, C/2, D50/2, D55/2, D65/2, D75/2, F2/2, F7/2, F11/2, A/10, C/10, D50/10, D55/10, D65/10, D75/10, F2/10, F7/10, and F11/10.

Note: Refer to the "Measurement Values" chapter for a description of each illuminant and observer.

- **Color Scale**: Choose the color scale you wish to see. Use the down arrow button to move down to the Color Scale parameter, then scroll through your choices using the right arrow button.

The available choices are XYZ, Yxy, Lab, L*a*b*, L*C*h, and dLdCdH (dLdCdH available only with Difference display type). If the display type chosen was Difference, the color scale will be expressed on the read screen as dXdYdZ, dYdxdy, dLdadb, dL*da*db*, or dL*dC*dh instead. The choice of (...) [none] is also available.

Note: Refer to the "Measurement Values" chapter for a description of each color scale.

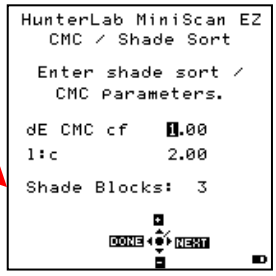
- **Color Index:** Choose the color index you wish to see. Use the down arrow button to move down to the Color Index parameter, then scroll through your choices using the right arrow button.

Your choices are Y, YID, YIE, WIE, Tint, Z%, 457B, MI, SMA, SW, OP, GSC, GSS, dE*, dEc, dE, dC*, dC, and SSN. If the display type chosen was Difference, the color index may be expressed on the read screen as a difference value, such as dY, dYIE, dWIE, etc. instead. The choice of (...) [none] is also available.

Some indices may not display until both a standard and a sample are read.

Note: Refer to the "Measurement Values" chapter for a description of each color index.

- **CMC/Shade Sort:** The CMC/Shade Sort parameter applies only if the color index chosen is dEc or SSN. Use the down arrow button to move down to the CMC/Shade Sort parameter, then press the right arrow button to obtain the CMC/Shade Sort screen.



As shown on the button pad map at the bottom of the screen, use the up and down arrow buttons to scroll up (+) and down (-) through the numbers for the digit that is currently highlighted. Press the right arrow button to move to the next digit in the value and then to move from the commercial factor to the l:c ratio and then to the Shade Blocks. Press the left arrow button when the needed values have been entered.

Note: Refer to the "Measurement Values" chapter for a description of each the CMC index values and the definition of shade blocks.

Press the left arrow button (Back) twice to return to the Product Setup screen.

Standard Values ▸

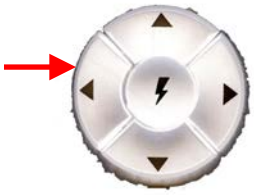
The Standard Values parameter is only relevant when the Standard Type is physical, numeric, or hitch. When Standard Values is highlighted, press the right arrow button to move to the Standard Values configuration screen.

For a **physical** standard, place the standard at the sample port and press the center button (Read) to read the standard and place its measurement values (in the selected color scale) in the product setup. Then press the left arrow button (Done) to return to the product setup configuration screen.

For a **numeric** standard, change the highlighted digit of the selected color scale value using the up and down arrow buttons. When the desired digit is shown, press Next to move to the next digit. When all digits are as desired, press Done to return to the product setup configuration screen.

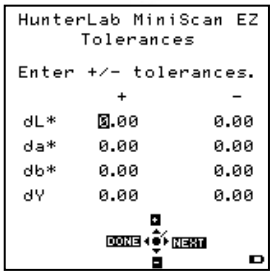
For a **hitch** standard, place the hitch standard (with known values from a reference instrument) at the sample port and press the center button (Read) to read the standard and place its measurement values (in the selected color

scale) in the product setup. Then, change the highlighted digit of the selected color scale value to match the corresponding digit of the known values from the reference instrument using the up and down arrow buttons. When the desired digit is shown, press Next to move to the next digit. When all digits match the corresponding digit from the reference instrument's reading, press Done to return to the product setup configuration screen.



Tolerances ▸

When Tolerances is highlighted, press the right arrow button to move to the Tolerances configuration screen, on which you may set tolerances in the chosen color scale and color index.



Change the highlighted digit of the selected color scale tolerance value using the up and down arrow buttons. When the desired digit is shown, press Next to move to the next digit. When all digits are as desired, press Done to return to the product setup configuration screen.

Autosearch

Select YES if you wish to include this product setup when using the automatic standard searching feature, which transfers you to the most appropriate product setup (based on the standard's color values) each time a

sample is read. Select NO if you do not which to include this product setup in automatic standard searching.

Press the right arrow button to toggle between YES and NO.

Press the left arrow button (Back) to accept the parameters just set and select another Product Setup to configure or the center button (Main Menu) to accept the parameters just set and return to the Main Menu.

Setup Maintenance

Setup Maintenance is selected from the main menu by moving the cursor highlight to its position using the up and down arrow buttons and then pressing the center (Go) button.

The Setup Maintenance menu appears.

Select the desired command from the menu by moving the cursor highlight to its position using the up and down arrow buttons and then pressing the right arrow button.

The available commands are described below.

Reset All Setups ▸

Reset All Setups first gives a confirmation message then, if Go is selected, returns all product setups to their default (factory) values.

Note: You will not be able to restore the default setups if the setups are locked in Global Options.

Print All Setups ▸

This command causes the product setup parameters to be output through the USB port for all the product setups. If the USB cable is connected to a printer, the parameters will be printed. If the cable is connected to a computer or other device, it will be sent there.

Note: You will need to open a receiving device in order to output setup parameters to a computer.

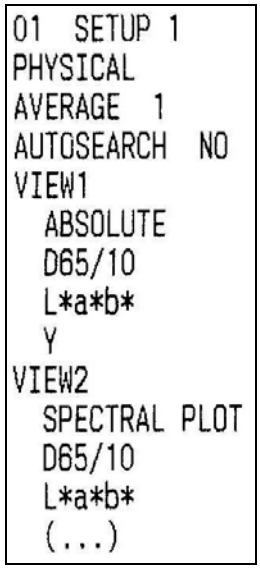
Print One Setup ▸

Print One Setup first gives a screen on which you must select the product setup you wish to print.

Select the desired setup from the list by moving the cursor highlight to its position using the up and down arrow buttons and then pressing the center (Print) button. The product setup's parameters are then output through the USB port. If the USB cable is connected to a printer, the parameters will be printed. If the cable is connected to a computer or other device, it will be sent there.

Note: You will need to open a receiving device in order to output setup parameters to a computer.

An example printout is shown below.



Clone All Setups ▸

Clone All Setups appears in the Setup Maintenance menu only when two MiniScan EZs are connected together via the standard MiniScan EZ USB cable and a Standard-A to Mini-A adapter. When Clone All Setups is chosen on one of the MiniScan EZs, the full set of 100 product setups are sent from the initiating instrument to the second connected instrument. This process takes several minutes.

Press Cancel to stop the setup cloning while it is in progress.

CHAPTER THREE

Standardization and Reading

This chapter describes the various steps you will perform in the course of normal instrument operations, including standardizing, reading, and storing and printing data.

Standardizing

Standardization sets the top and bottom of scale for the neutral axis. During standardization, the bottom of the scale (zero) is set first. For this, you simulate the case where all the source light is absorbed by the sample. This is done by placing the black glass or light trap that is contained in the calibration "can" at the sample port. The top of the scale is then set by scaling the light which is reflected back from the calibrated white tile also in the calibration can. Messages on the LCD screen prompt you through the standardization process as described below.

It is recommended that the MiniScan EZ be standardized at least once every four hours. The instrument will automatically prompt for standardization after the Standardization Interval set in Global Options has elapsed, so it is a good idea to enter 4 hours as the Standardization Interval. Also standardize the MiniScan EZ any time there is a significant change

(greater than 5°F) in ambient temperature. For example, if you move your MiniScan EZ from your air-conditioned office to an outdoor site that is 90°F, you should standardize again outdoors after the instrument has had a chance to stabilize under the new temperature.

Also, it is very important that the standards used in standardization be treated carefully. They must be clean and in good condition if standardization is to be successful. If there is any doubt about the standards being clean, clean them as described in the "Maintaining and Testing MiniScan EZ" chapter.

Standardization Process

Standardization of a MiniScan EZ is performed as follows:

1. Remove the calibration cylinder from the carrying case.

Note: If your MiniScan EZ is a 45°/0° model, your cylinder will contain a black glass. If it is a diffuse/8° (sphere) model, it will contain a light trap.

2. Check that the tiles are clean and that the light trap is free of dust and scratches. If they are dirty (including marked with fingerprints), clean them as described in "Maintaining and Testing MiniScan EZ."

3. Select Standardize from the MiniScan EZ's main menu by moving the cursor highlight to its position using the up and down arrow buttons and then pressing the center (Go) button. The Standardization screen appears, prompting you to place the black glass or light trap.

4. Remove the end cap of the calibration cylinder that covers the black glass and press the nose cone of the MiniScan EZ to the shiny side of the glass. **Check that the sample port is flat against the black glass.**

   OR

   Remove the end cap of the calibration cylinder that covers the light trap and cover the MiniScan EZ's sample port with the light trap. C**heck that the light trap completely covers the port.**

5. Press the center button (Go). The MiniScan EZ reads the glass or trap and sets the instrument zero. When it is finished, the screen prompts you to place the white tile.

6. Replace the black glass or light trap with the white tile, which is contained in the calibration can's end cap. Press the nose cone of the MiniScan EZ to the white side of the tile. **Check that the sample port is flat against the tile.**

7. Press the center button (Go). The MiniScan EZ reads the white tile and sets the top of scale. When it is finished, the screen indicates that the instrument has been successfully standardized.

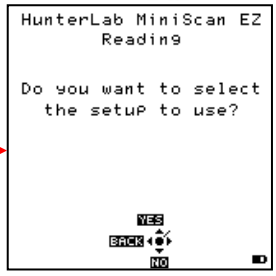
8. Press Main Menu (right arrow) to return to the main menu.

Reading Individual Samples

Complete the following steps to take individual (non-averaged) readings using the MiniScan EZ:

Note: These instructions apply when Average in the product setup is set to OFF.

1. Select Read from the MiniScan EZ's main menu. Move the cursor highlight to its position using the up and down arrow buttons and then press the center (Go) button.



2. The first Reading screen appears, asking if you want to select the setup to use. If you want to read using the last product setup that was used, press No (down arrow) and skip to Step 4. If you want to select the setup for use from the list of setups, press Yes (up arrow), and the Select setup to use screen appears.

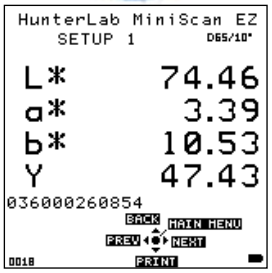
3. Scroll through the list of setups using the up and down arrow buttons until the setup you wish to use is highlighted, then press the center button (Go) to move to that setup.

4. The first reading screen appears, which prompts you to read the standard (if the product setup uses a working standard) or sample.

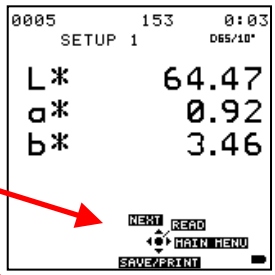
5. Place the standard or sample at the sample port with the side to be measured toward the port. Make sure that the item is flat against the port and completely covers it.

6. Press the center (Go) button to read. The standard or sample is read and its values (as configured in the product setup) displayed on the screen.

Note: If you have a bar code reader installed, scan your bar code now, and the ID will appear beneath the color measurement.



7. Note that the meanings of the keypad buttons have now changed slightly, as shown on the keypad map at the bottom of the screen.



Press Save/Print (down arrow) to both save the reading in the MiniScan EZ's memory and print the reading (if a USB printer is connected.) An example of a printout is shown below.

SETUP 1

2008/06/19 08:00
D65/10 1/1

L*	87.02
a*	1.74
b*	-7.16
Y	70.04

Press Read (center button) to take another reading in this product setup.

Press Next (up arrow) if it is an option to move to the next data view for this product setup.

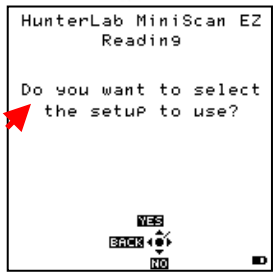
Press Main Menu (right arrow) to return to the main menu.

Reading With Averaging

Complete the following steps to take and average multiple readings using the MiniScan EZ:

Note: These instructions apply when Average in the product setup is set to a value other than OFF.

1. Select Read from the MiniScan EZ's main menu. Move the cursor highlight to its position using the up and down arrow buttons and then press the center (Go) button.



2. The first Reading screen appears, asking if you want to select the setup to use. If you want to read using the last product setup that was used, press No (down arrow) and skip to Step 4. If you want to select the setup for use from the list of setups, press Yes (up arrow), and the Select setup to use screen appears.

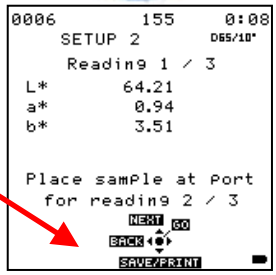
3. Scroll through the list of setups using the up and down arrow buttons until the setup you wish to use is highlighted, then press the center button (Go) to move to that setup.

4. The first reading screen appears, which prompts you to place the standard for reading 1 of n (if the product setup uses a working standard) or sample for reading 1 of n.

5. Place the standard or sample at the sample port with the side to be measured toward the port. Make sure the item is flat against the port and completely covers it.

6. Press the center (Go) button to read. The standard or sample is read and its values (as configured in the product setup) displayed on the screen.

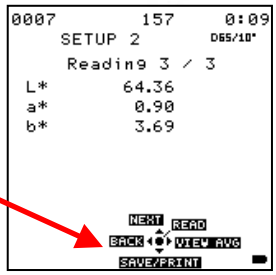
7. Note that the meanings of the keypad buttons have now changed slightly, as shown on the keypad map at the bottom of the screen.



Press Save/Print (down arrow) to both save the reading in the MiniScan EZ's memory and print the reading (if a USB printer is connected).

Press Go (center button) to make the next reading in the averaging sequence. (You may wish to rotate or reposition the sample before doing so.)

8. After all readings in the averaging sequence have been made, the meanings of the keypad buttons will change again.



Press Save/Print (down arrow) to both save the reading in the MiniScan EZ's memory and print the reading (if a USB printer is connected).

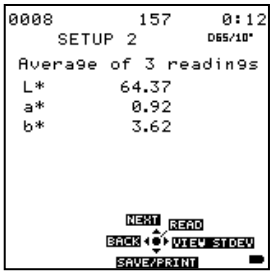
Press Next (up arrow) if it is shown to move to the next data view in the product setup.

Press View Avg (right arrow) to show the average of all the measurements made in the averaging sequence.

Note: If you have a bar code reader installed, scan your bar code now, and the ID will appear beneath the average color values.

Press Read (center button) to take another reading in this product setup.

9. Once the average is displayed, you may press View Stdev (right arrow) to show the standard deviation of all the measurements made in the averaging sequence.



10. Once the standard deviation is displayed, you may press Main Menu (right arrow) to return to the main menu.

Working with Saved Readings

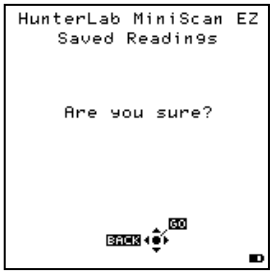
Readings stored in the MiniScan EZ's memory during the read process may be viewed, printed, and deleted later, if desired.

To work with saved readings, select Saved Readings from the main menu by moving the cursor highlight to its position using the up and down arrow buttons and then pressing the center (Go) button. The Saved Readings menu appears.

Choose the desired function by scrolling using the up and down arrow buttons until it is highlighted and then pressing the right arrow button. The various functions perform as described below.

Delete All Readings ▸

Delete All Saved Readings causes a confirmation message to be shown. When you press Go (center button), all the measurements stored in the MiniScan EZ's memory are erased. When complete, a confirmation message is shown and then you are returned to the Saved Readings menu.

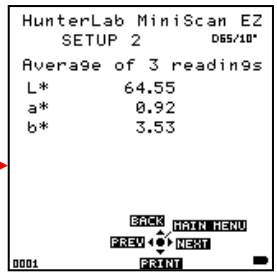


Print All Readings ▸

Print All Readings causes all the measurements stored in the MiniScan EZ's memory to be output to the device (such as a computer) or printer connected to the MiniScan EZ's USB port. When complete, you are returned to the Saved Readings menu.

View Saved Readings ▸

View Saved Readings allows you to view and scroll through the readings saved in the MiniScan EZ's memory. The first reading stored in memory (which was assigned an ID of 0001 by default) will be shown first.



Press Print (down arrow) to output the saved reading currently shown to the device (such as a computer) or printer connected to the MiniScan EZ's USB port.

Press Next (right arrow) to move forward to the next saved reading or Prev (left arrow) to move back to the previous saved reading.

Press Back (up arrow) to return to the Saved Readings menu or Main Menu (center button) to return to the main menu.

Filter By Setup ▸

Filter By Setup allows you to view readings saved in the MiniScan EZ's memory by choosing the product setup used to measure the readings of interest. The Saved Readings screen that allows you to choose the appropriate setup is shown first.

Scroll through the setups using the up and down arrow buttons until the setup you want is highlighted, then press Go (center button). You may also scroll through the list of setups by advancing a page at a time using the Page (right arrow) button.

View, print, and move through the readings saved for this setup in the same way described above for "View Saved Readings."

CHAPTER FOUR

Lessons

This chapter provides eight lessons that walk you step-by-step through some common MiniScan EZ applications. You can try some of the lessons or all of the lessons, which teach you about the features listed below.

Lesson 1: Showing Multiple Color Scales or Display Types for a Single Sample

Lesson 2: Matching the MiniScan EZ to a Reference Instrument (The Hitch Standard)

Lesson 3: Automatically Generating Color Tolerances (CMC)

Lesson 4: Displaying Metamerism Index

Lesson 5: Measuring Opacity

Lesson 6: Searching for the Closest Standard to a Read Sample

Lesson 7: Using Colorant Strength

Lesson 8: Using Shade Numbering.

Note: The product setups created using these lessons are examples only. In many cases, you may personalize these setups to include your desired color scale, display type, averaging setting, etc.

It is suggested that you standardize the instrument before beginning the lessons.

Lesson 1: Showing Multiple Color Scales or Display Types for a Single Sample

In order to obtain readings of a single sample in reference to different color scales (or different illuminants, or to view different display types, such as absolute color values and a spectral plot), complete the following steps:

1. From the Main Menu, choose Product Setup. You are asked if you would like to select the setup to configure.

2. Select Yes. You are shown a screen from which you can choose the setup you wish to configure.

3. Select Setup 10. The Product Setup screen for Setup 10 is shown.

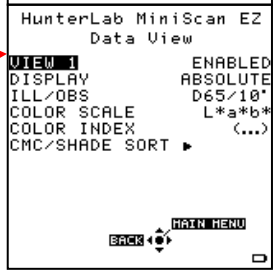
4. Change the name of the setup to LESSON 1.

5. Set the standard type to WORKING.

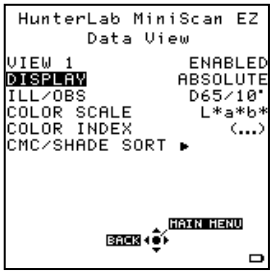
6. Set Average to OFF.

7. Select Views ▸. The Data Views screen appears.

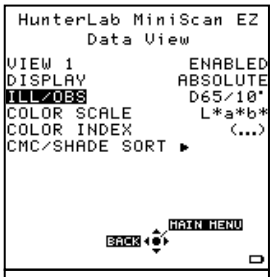
8. Select View 1. It is enabled by default.



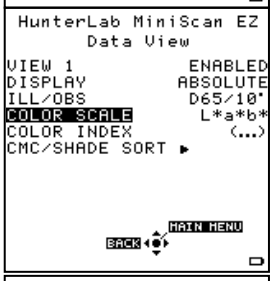
9. Set Display to ABSOLUTE.



10. Set Ill/Obs to D65/10°.



11. Set Color Scale to L*a*b*.



12. Set Color Index to Y.

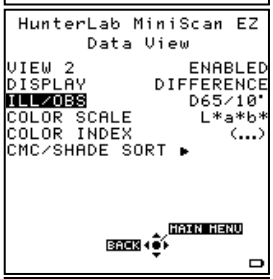
13. Since we're not using the dEc index or shade numbering, CMC/Shade Sort is not relevant, so press Back to go back to the Data Views screen.

14. Select View 2.

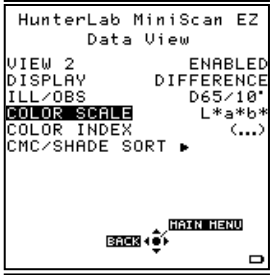
15. Enable View 2.

16. Set Display to DIFFERENCE.

17. Set Ill/Obs to D65/10°.

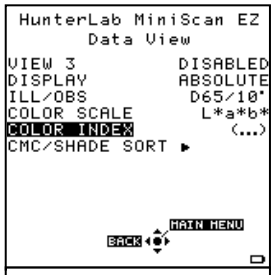


18. Set Color Scale to L*a*b*. (It will display as dL*da*db* after samples are read because the Display type is DIFFERENCE.)

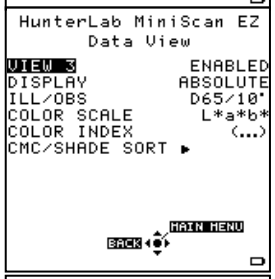


19. Set Color Index to Y. (It will display as dY after samples are read because the Display type is DIFFERENCE.)

20. Press Back to go back to the Data Views screen.
21. Select View 3.

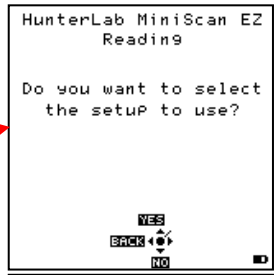


22. Enable View 3.



23. Set Display to SPECTRAL PLOT.
24. Since we are asking to see a spectral plot rather than colorimetric data, the rest of the parameters on this screen are not relevant. Press Main Menu (center button) to return to the Main Menu.

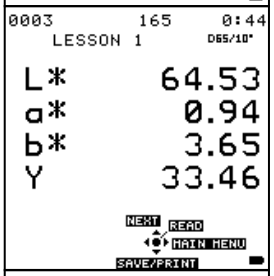
25. Choose Read. You are asked if you wish to select the setup to use.
26. Choose Yes.



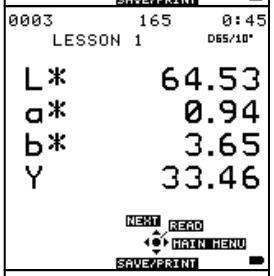
27. From the list of product setups, select 10: LESSON 1.

28. You are prompted to place the standard at the port. Do so and press Go.

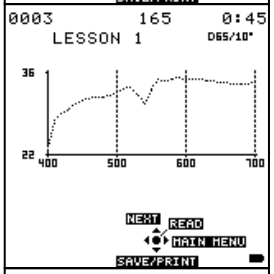
29. The MiniScan EZ reads the standard and displays L*, a*, b* and Y for the D65/10° illuminant/observer combination. These were the settings configured for View 1.



30. Press Next to move to View 2. L*, a*, b* and Y are again shown for the standard reading.



31. Press Next to move to View 3. The spectral plot for the standard is shown.

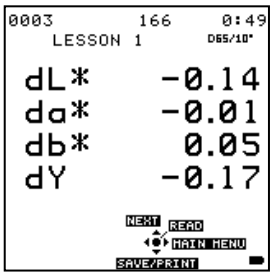


32. Press Read. You are prompted to place the sample at the port. Do so and press Go.

33. The MiniScan EZ reads the sample and displays its spectral plot, since we are still situated in View 3.

34. Press Next to move to View 1. L*, a*, b*, and Y for the D65/10° illuminant/observer combination are shown for the sample.

35. Press Next to move to View 2. dL*, da*, db*, and dY for the D65/10° illuminant/observer combination are shown for the sample versus the standard.



36. Press Read to read another sample or Main Menu to return to the Main Menu.

Lesson 2: Matching the MiniScan EZ to a Reference Instrument (The Hitch Standard)

Using a Hitch standard type is a way to make several instruments read samples of a color similar to that of the hitch standard in the same way. The hitch standard is measured on the MiniScan EZ and the values corrected to match those from another instrument. Several MiniScan EZ instruments can be hitched together or MiniScan EZ can be hitched to another color measurement instrument, such as one in your laboratory or one used by a customer.

For this lesson, assume that you have a product standard available that you have measured on a colorimeter in your lab. The colorimeter reported the following color values for the standard using illuminant C and the 2° standard observer:

X = 81.10 Y = 85.91 Z = 92.02

Once your MiniScan EZ is hitched to these values for the product standard, you can then take the MiniScan EZ out of the lab to read some samples. These measurement values will look very much like you made them on your laboratory instrument.

1. From the Main Menu, choose Product Setup. You are asked if you would like to select the setup to configure.

2. Select Yes. You are shown a screen from which you can choose the setup you wish to configure.

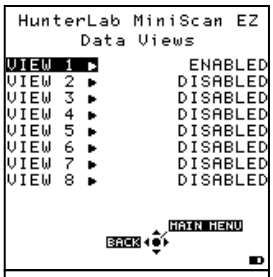
3. Select Setup 11. The Product Setup screen for Setup 11 is shown.

4. Change the name of the setup to LESSON 2.

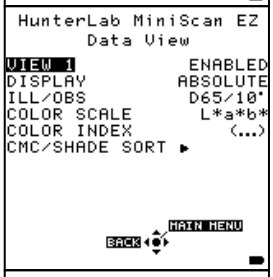
5. Set the standard type to HITCH.

6. Set Average to OFF.

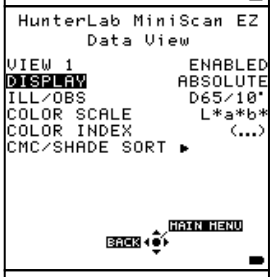
7. Select Views ▸. The Data Views screen appears.



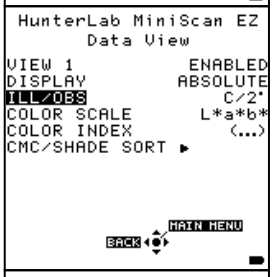
8. Select View 1. It is enabled by default.



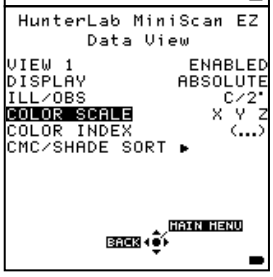
9. Set Display to ABSOLUTE.



10. Set Ill/Obs to C/2°.

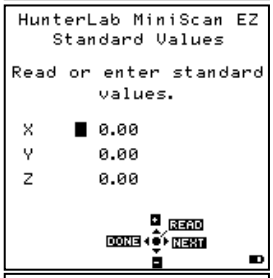


11. Set Color Scale to XYZ.



12. Press Back to go back to the Data Views screen and then Back again to return to the Product Setup screen.

13. Select Standard Values. The Standard Values screen appears.



14. Place the MiniScan EZ on the product standard that was read on the reference instrument and press the center button (Read). The XYZ values read on the MiniScan EZ are displayed with the first digit of the X values highlighted.

15. Modify each digit of the XYZ values read until they match those of the hitch standard read on the reference instrument (X = 81.10, Y = 85.91, Z = 92.02).

16. Press Done to return to the product setup screen.

17. Press Main Menu to return to the Main Menu.

18. Choose Read. You are asked if you wish to select the setup to use.

19. Choose Yes.

20. From the list of product setups, select 11: LESSON 2.

21. Follow the prompts to read your samples. Any measurements made in this setup will be adjusted to match the reference instrument.

Note: You should create a product setup using a hitch standard for each color you wish to measure. For instance, do not use a blue hitch standard when measuring yellow samples.

Lesson 3: Automatically Generating Color Tolerances (CMC)

If you establish a product setup that includes the dEc color index, you may then set the commercial factor (cf) and l:c (lightness to chroma) ratio and allow the MiniScan EZ to automatically calculate color tolerances for your product standard. This is beneficial when you are measuring a product standard for the first time and you're not sure what tolerances to enter.

Note: See the Measurement Values chapter for a thorough description of the CMC color index.

1. From the Main Menu, choose Product Setup. You are asked if you would like to select the setup to configure.

2. Select Yes. You are shown a screen on which you can choose the setup you wish to configure.

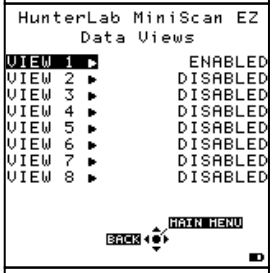
3. Select Setup 12. The Product Setup screen for Setup 12 is shown.

4. Change the name of the setup to LESSON 3.

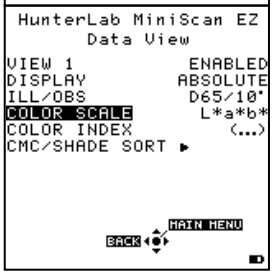
5. Set the standard type to PHYSICAL.

6. Set Average to OFF.

7. Select Views ▸. The Data Views screen appears.

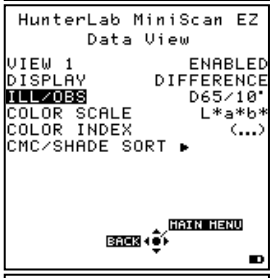


8. Select View 1. It is enabled by default.

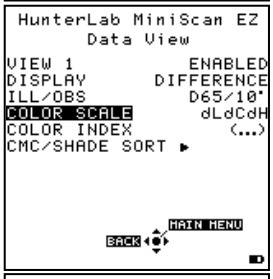


9. Set Display to DIFFERENCE.

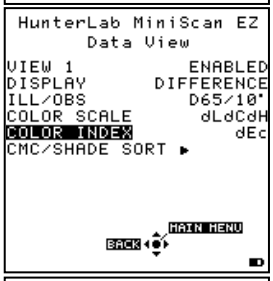
10. Set Ill/Obs to D65/10°.



11. Set Color Scale to dLdCdH.



12. Set Color Index to dEc.



13. Select CMC/Shade Sort. The CMC/Shade Sort screen is obtained.

14. Enter 1.25 for the commercial factor (cf). This broadens the tolerance slightly beyond what is normally used (1).

15. Enter 1.00 for the l:c ratio. This indicates that lightness and chroma differences are of equal importance. The ratio normally used is 2.00.

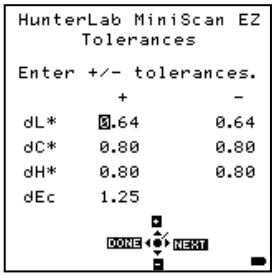
16. We are not using shade numbering, so the Shade Blocks field is not relevant. Press Done to go back to the Data View screen and then Back to return to The Data Views screen. Press Back again to return to the Product Setup screen.

17. Select Standard Values ▸. The Standard Values screen is obtained.

18. Place the MiniScan EZ's measurement port over the product standard and press Read. The standard is read and its color values placed into the product setup.

19. Press Done to return to the Product Setup screen.

20. Select Tolerances. The Tolerances screen is shown. Note that + and - tolerances for dL*, dC*, and dH* have been calculated. The dEc shown is as set for cf at Step 14. These values may be adjusted if desired.



21. Press Done to return to the product setup screen.

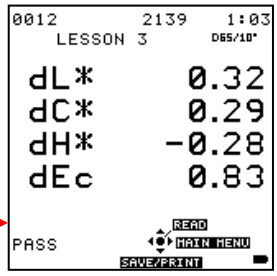
22. Press Main Menu to return to the main menu.

23. Select Read.

24. At the question "Do you want to select the setup to use?" answer Yes.

25. Select 12: LESSON 3.

26. Place the MiniScan EZ on an item to use as a sample and press Go. The difference in color between the standard and this sample is displayed as dL*dC*dH* and dEc, as well as whether the sample passes or fails based on the automatically-generated tolerances.



27. Press the down arrow button (Save/Print) to store this measurement in the MiniScan EZ memory, as well as print the reading if the instrument is connected to a printer.

Lesson 4: Displaying Metamerism Index

Metamerism is present when two objects appear to be the same color under one illuminant or light source, but different in another. This is due to the fact that their spectral curves fail to match under the second illuminant. If the spectral curves for two items cross at three or more points, this is an indication of a metameric match.

As a general rule, a metamerism index of 0.50 or less would probably indicate an acceptable match visually. A metamerism value from 0.50 to 1.00 would indicate that the match *may* be visually unacceptable. A metamerism value greater than 1.00 would require reformulation.

To display metamerism index with the MiniScan EZ, you must create a product setups with two data views that use different illuminant/observer combinations. Metamerism Index should be selected for display in the second data view.

1. From the Main Menu, choose Product Setup. You are asked if you would like to select the setup to configure.

2. Select Yes. You are shown a screen on which you can choose the setup you wish to configure.

3. Select Setup 13. The Product Setup screen for Setup 13 is shown.

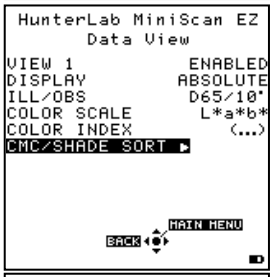
4. Change the name of the setup to LESSON 4.

5. Set the standard type to WORKING.

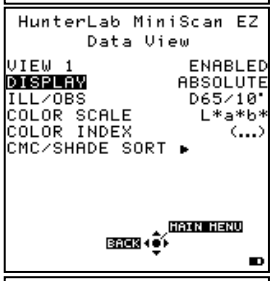
6. Set Average to OFF.

7. Select Views ▸. The Data Views screen appears.

8. Select View 1. It is enabled by default.

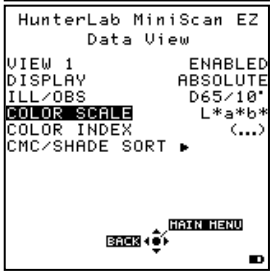


9. Set Display to ABSOLUTE.



10. Set Ill/Obs to D65/10°. This is the first illuminant that will be used in the metamerism index calculation.

11. Set Color Scale to L*a*b*.

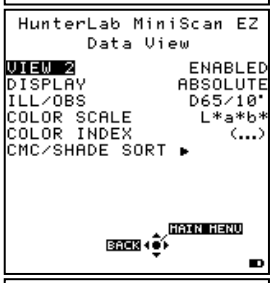


12. Set Color Index to dE*.

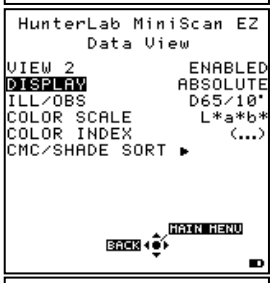
13. Press Back to go back to the Data Views screen.

14. Select View 2.

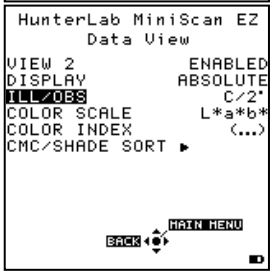
15. Enable View 2.



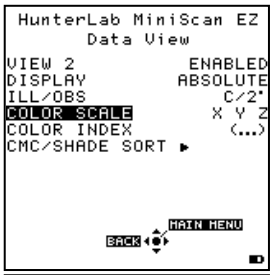
16. Set Display to ABSOLUTE.



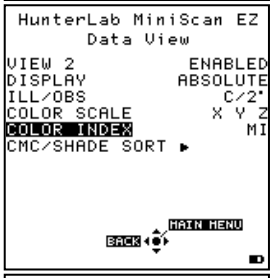
17. Set Ill/Obs to C/2°. This is the second illuminant that will be used in calculating metamerism index.



18. Set Color Scale to XYZ.

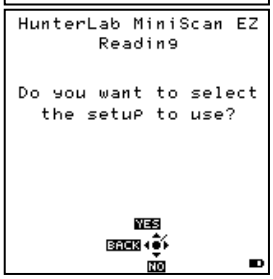


19. Set Color Index to MI (metamerism index).



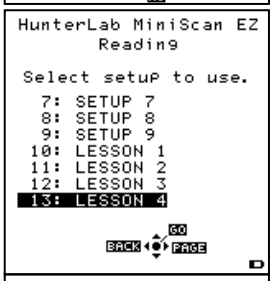
20. Press Main Menu (center button) to return to the Main Menu.

21. Choose Read. You are asked if you wish to select the setup to use.



22. Choose Yes.

23. From the list of product setups, select 13: LESSON 4.

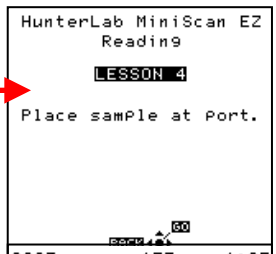


24. You are prompted to place the standard at the port. Do so and press Go.

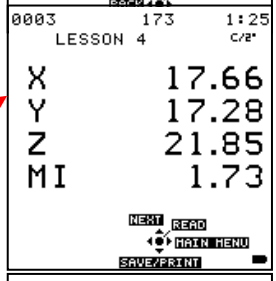
25. The MiniScan EZ reads the standard and displays L*a*b* and dE* (which will be zero, since this is the standard's reading) for the D65/10° illuminant/observer combination. These were the settings configured for View 1.

26. Press Next to move to View 2. XYZ and MI (which will be zero, since this is the standard's reading) are shown for the standard reading under the C/2° illuminant/observer combination. These were the settings configured for View 2.

27. Press Read. You are prompted to place the sample at the port. Do so and press Go.



28. The MiniScan EZ reads the sample and displays XYZ and MI values for C/2°, since we are still situated in View 2.



29. Press Next to move to View 1. L*, a*, b*, and dE* for the D65/10° illuminant/observer combination are shown for the sample.

30. Press Read to read another sample or Main Menu to return to the Main Menu.

Lesson 5: Measuring Opacity

You may use the MiniScan EZ to determine how opaque samples are. You will need to have a white backing and black backing handy in order to make opacity measurements. Two readings of each sample are required to measure opacity.

1. From the Main Menu, choose Product Setup. You are asked if you would like to select the setup to configure.

2. Select Yes. You are shown a screen on which you can choose the setup you wish to configure.

3. Select Setup 14. The Product Setup screen for Setup 14 is shown.

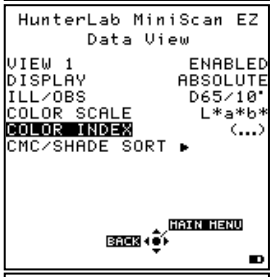
4. Change the name of the setup to LESSON 5.

5. Set the standard type to WORKING.

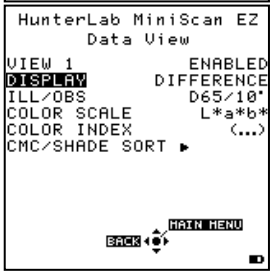
6. Set Average to OFF.

7. Select Views ▶. The Data Views screen appears.

8. Select View 1. It is enabled by default.

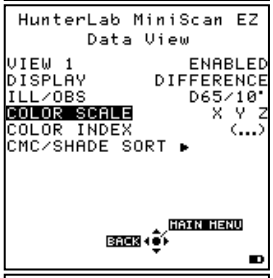


9. Set Display to DIFFERENCE.

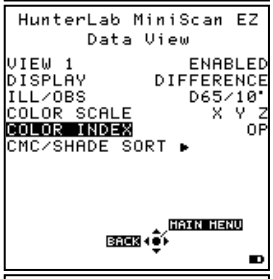


10. Set Ill/Obs to D65/10°.

11. Set Color Scale to XYZ.



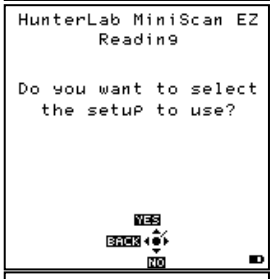
12. Set Color Index to OP (opacity).



13. Press Main Menu to return to the Main Menu.

14. Choose Read. You are asked if you wish to select the setup to use.

15. Choose Yes.

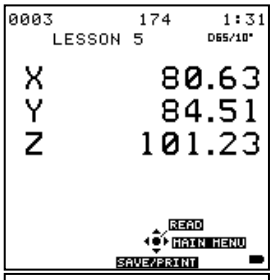


16. From the list of product setups, select 14: LESSON 5.

17. You are prompted to place the sample with a white backing.

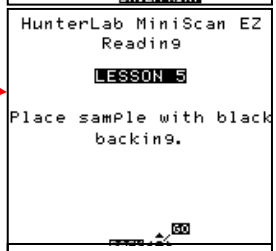
18. Place an uncalibrated white tile or other white backing face up on a flat surface, then place your sample face up on top of it.

19. Place the MiniScan EZ on the white-backed sample and press Go. The absolute XYZ values are shown.

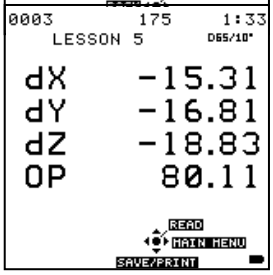


20. Press Read again. You are prompted to place the sample with a black backing.

21. Place the black glass or another black backing face up on your flat surface, then place your sample face up on top of it.



22. Place the MiniScan EZ on the black-backed sample and press Go. The dXdYdZ and opacity values will be shown.



23. Press Read to initiate reading of another sample or Main Menu to return to the main menu.

Lesson 6: Searching for the Closest Standard to a Read Sample

The MiniScan EZ can be configured to automatically select the best product setup for use when a sample is read. The "best" setup is the one where the color of the physical, numeric, or hitch standard is closest to that of the sample. The procedure for using the automatic standard search feature is described in this lesson. For this example, the comparison of standard and sample will be performed using the dE* index.

You should begin with a standardized instrument.

1. From the Main Menu, choose Product Setup. You are asked if you would like to select the setup to configure.
2. Select Yes. You are shown a screen on which you can choose the setup you wish to configure.
3. Select Setup 15. The Product Setup screen for Setup 15 is shown.

4. Change the name of the setup to RED.

5. Set the standard type to PHYSICAL.

6. Set Average to OFF.

7. Select Views ▸. The Data Views screen appears.

8. Select View 1. It is enabled by default.

9. Set Display to SPECTRAL DATA.

10. Since we'll be viewing spectral data rather than colorimetric data, the rest of the parameters are not relevant, so press Back to go back to the Data Views screen and Back again to go to the Product Setup screen for the Red setup.

11. Select Standard Values ▸. Place the MiniScan EZ on something that is red and press Read to read it.

12. Press Done to return to the Product Setup screen for the Red setup.

13. Set Autosearch to YES.

14. Press Back to return to the screen where you can select a setup to configure.

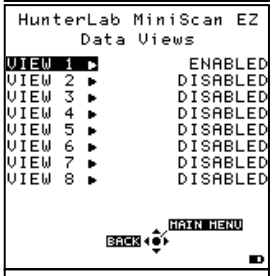
15. Choose to configure Setup 16.

16. Change the name of the setup to YELLOW.

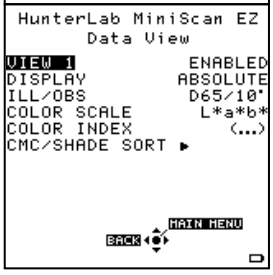
17. Set the standard type to NUMERIC.

18. Set Average to OFF.

19. Select Views ▸. The Data Views screen appears.



20. Select View 1. It is enabled by default.



21. Set Display to SPECTRAL PLOT.

22. Since we're displaying a spectral plot, the rest of the parameters on this screen are not relevant. Press Back to go back to the Data Views screen and Back again to return to the Product Setup screen for the Yellow setup.

23. Select Standard Values ▸. Enter 90.64 for L*, -2.09 for a*, and 38.60 for b*, which falls in the yellow region of color space..

24. Press Done to return to the Product Setup screen for Yellow.

25. Set Autosearch to YES.

26. Press Back to return to the Select setup to configure screen.

27. Select SETUP 17.

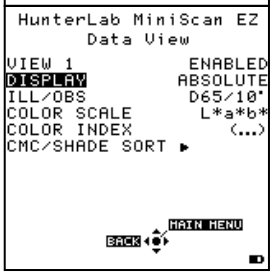
28. Change the name of the setup to BLUE.

29. Set the standard type to HITCH.

30. Set Average to OFF.

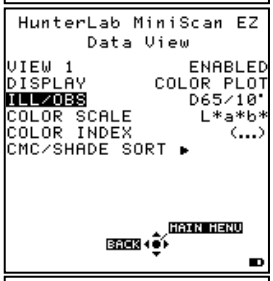
31. Select Views ▸. The Data Views screen appears.

32. Select View 1. It is enabled by default.



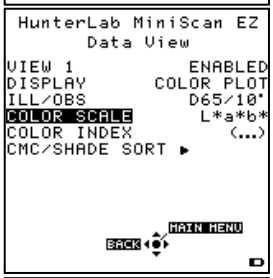
33. Set Display to COLOR PLOT.

34. Set Ill/Obs to D65/10.

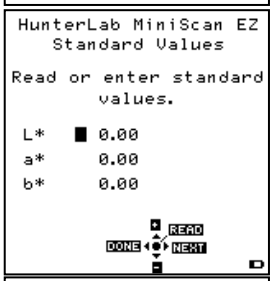


35. Set Color Scale to L*a*b*.

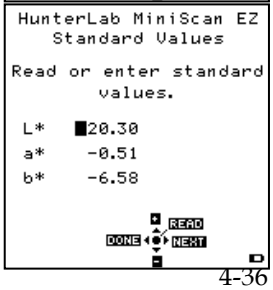
36. Press Back to return to the Data Views screen and then Back again to return to the Product Setup screen for Blue.



37. Select Standard Values ▸. The Standard Values screen appears.



38. Read a blue item that we will pretend is a hitch standard for purposes of this lesson.



39. Alter the standard values slightly as if we had known values from another instrument we wish to use in hitching.

40. Press Done to return to the Product Setup screen.

41. Set Autosearch to Yes.

42. Press Main Menu to return to the main menu.

43. Select Global Options. The Global Options screen appears.

44. Select Autosearch ▸. The Autosearch screen is shown.

45. Select dE* for Color Diff.

46. Select OFF for Average.

47. Press Back to return to Global Options.

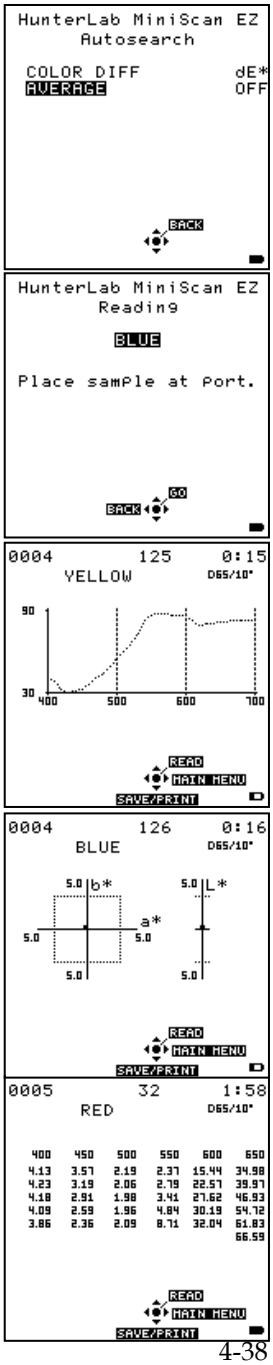
48. Press Main Menu to return to the main menu.

49. Select Read. The prompt "Place sample at port" is shown.

50. Place the MiniScan EZ on something yellow and press Go. You should be transferred to the Yellow product setup.

51. Place the MiniScan EZ on your blue item again and press Go. You should be transferred to the Blue product setup.

52. Place the MiniScan EZ on your red item again and press Go. You should be transferred to the Red product setup.



53. If you will be continuing with the next lesson, return to Global Options and set Color Diff under Autosearch ▸ to (...) so that autosearching will not be used for the remaining lessons.

Lesson 7: Using Colorant Strength

You may choose to calculate colorant strength based on either the wavelength of maximum absorbance or the tristimulus values weighted by the illuminant. The color values shown on the MiniScan EZ's screen would then be adjusted based on the colorant strength. In this lesson, we will demonstrate the difference between strength-corrected values and raw color values.

1. From the Main Menu, choose Product Setup. You are asked if you would like to select the setup to configure.

2. Select Yes. You are shown a screen on which you can choose the setup you wish to configure.

3. Select Setup 18. The Product Setup screen for Setup 18 is shown.

4. Change the name of the setup to LESSON 7.

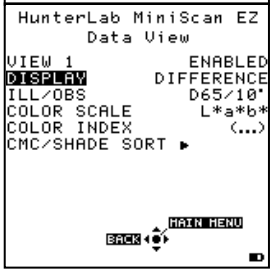
5. Set the standard type to WORKING.

6. Set Average to OFF.

7. Select Views ▸. The Data Views screen appears.

8. Select View 1. It is enabled by default.

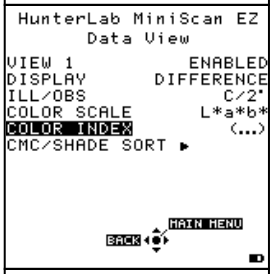
9. Set Display to DIFFERENCE.



10. Set Ill/Obs to C/2°.

11. Set Color Scale to L*a*b*. (It will display as dL*da*db* after samples are read because the Display type is DIFFERENCE.)

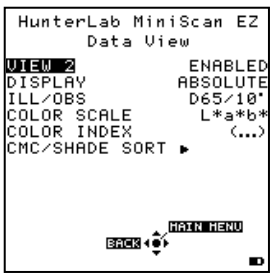
12. Set Color Index to (...) [None].



13. Since we're not using the dEc index or shade numbering, CMC/Shade Sort is not relevant, so press Back to go back to the Data Views screen.

14. Select View 2.

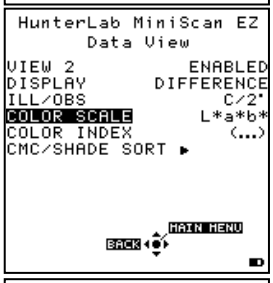
15. Enable View 2.



16. Set Display to DIFFERENCE.

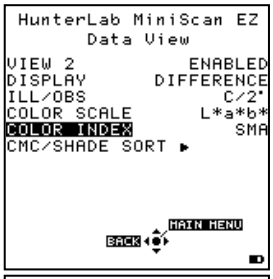
17. Set Ill/Obs to C/2°.

18. Set Color Scale to L*a*b*. (It will display as dL*da*db* after samples are read because the Display type is DIFFERENCE.)



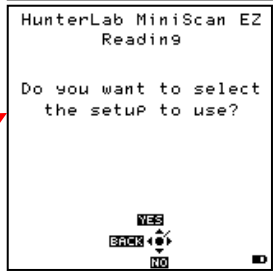
19. Set Color Index to SMA (strength maximum absorbance).

20. Press Main Menu to return to the main menu.



21. Choose Read. You are asked if you wish to select the setup to use.

22. Choose Yes.

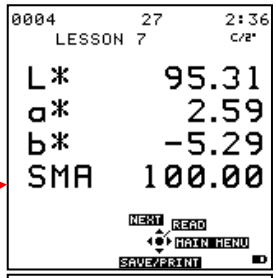


23. From the list of product setups, select 18: LESSON 7.

24. You are prompted to place the standard at the port. Do so and press Go.

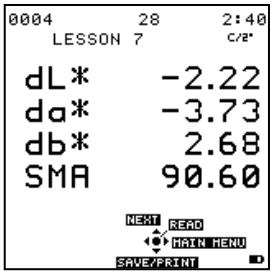
25. The MiniScan EZ reads the standard and displays L*, a*, and b* for the C/2° illuminant/observer combination. These were the settings configured for View 1.

26. Press Next to move to View 2. L*, a*, and b* are again shown for the standard reading, and SMA is shown as 100, since the strength of the standard is always 100%.



27. Press Read. You are prompted to place the sample at the port. Do so and press Go.

28. The MiniScan EZ reads the sample and displays the strength-adjusted dL*, da*, and db* values along with the strength itself, since we are still situated in View 2.



29. Press Next to move to View 1. Unadjusted dL*, da*, and db* for the C/2° illuminant/observer combination are shown for the sample versus the standard.

30. Press Read to read another sample or Main Menu to return to the Main Menu.

Lesson 8: Using Shade Numbering

Shade numbering is a means of sorting products into groups (or "blocks") based on their color. It is primarily used in the textile industry. The most commonly used shade numbering system is the 555 system. Each 5 corresponds to a component of the color scale being used (such as L, a, and b). The standard is assigned the shade number of 555. Any samples whose color values are within a certain percentage of the tolerance for this standard are given the same shade number. Theoretically, all samples with the same shade number are not perceptibly different from each other and may be used together to produce an end product in which all the parts match. The limits of each shade number block are determined by the tolerances and the number of shade blocks configured.

Note: See the Measurement Values chapter for a thorough description of the Shade Numbering color index.

If you are unsure what your tolerances should be, you might, at first, opt to use shade numbering in conjunction with CMC autotolerancing to optimize your shade numbering tolerances. Refer to Lesson 3 for information on CMC tolerancing. This lesson will generate shade numbers by manually entering rectangular tolerances, not by using CMC.

1. From the Main Menu, choose Product Setup. You are asked if you would like to select the setup to configure.

2. Select Yes. You are shown a screen on which you can choose the setup you wish to configure.

3. Select Setup 19. The Product Setup screen for Setup 19 is shown.

4. Change the name of the setup to LESSON 8.

5. Set the standard type to PHYSICAL.

6. Set AVERAGE to 2.

7. Select Views ▸. The Data Views screen appears.

8. Select View 1. It is enabled by default.

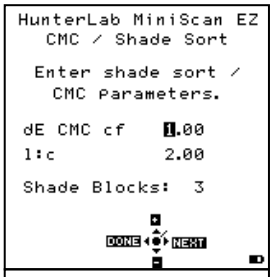
9. Set Display to DIFFERENCE.

10. Set Ill/Obs to D65/10°.

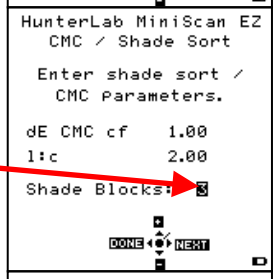
11. Set Color Scale to L*a*b*.

12. Set Color Index to SSN.

13. Select CMC/Shade Sort. The CMC/Shade Sort screen is obtained.



14. Press Next multiple times until the Shade Blocks field is highlighted.



15. For purposes of this lesson, select 5. That means five shade number blocks (3, 4, 5, 6, and 7) will fall within your tolerance for each component of the color scale.

16. Press Done to return to the Data View screen and then Back twice to return to the Product Setup screen.

17. Select Standard Values ▸. The Standard Values screen is obtained.

18. Place the MiniScan EZ's measurement port over the product standard and press Read. The standard is read and its color values placed into the product setup.

19. Press Done to return to the Product Setup screen.

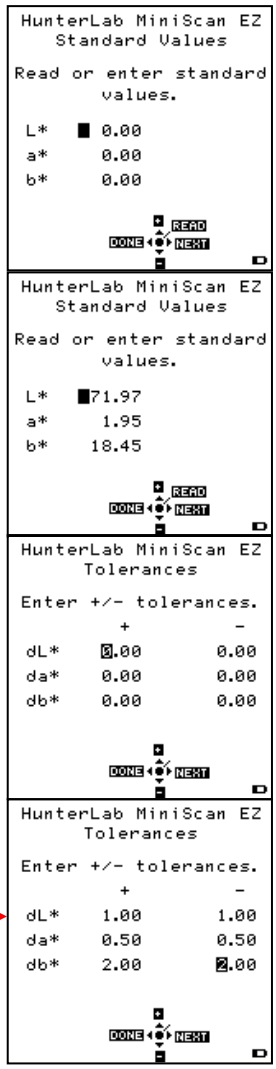
20. Select Tolerances. The Tolerances screen is shown.

21. Enter your tolerances for dL*, da*, and db*. For this lesson, enter ±1.00 for dL*, ±0.50 for da*, and ±2.00 for b*. Since we chose to fit 5 shade blocks within the tolerance, each block will be 0.20 units wide in the L* direction (1.00/5), 0.10 units wide in the a* direction (0.50/5), and 0.4 units wide in the b* direction (2.00/5).

22. Press Done to return to the Product Setup screen.

23. Press Main Menu to return to the main menu.

24. Select Read.



25. At the question "Do you want to select the setup to use?" answer Yes.

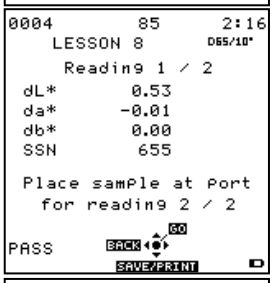
26. Select 19: LESSON 8. You are prompted to place the sample for the first reading.

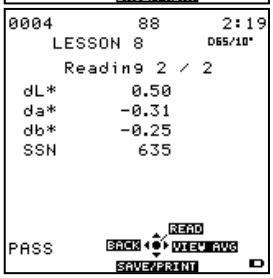
27. Place the MiniScan EZ on an item to use as a sample and press Go. The difference in color between the standard and this first reading of the sample is displayed as dL*da*db* and SSN, as well as whether the sample passes or fails based on the entered tolerances.

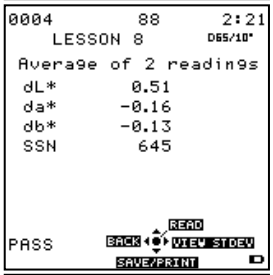
28. Rotate the sample 90° and read it again. The data for this second reading of the sample are displayed.

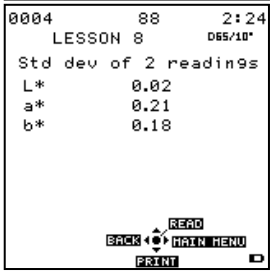
29. Press View Avg to show the average of the two sample readings.

30. Press View Stdev to show the standard deviation of the two sample readings.









CHAPTER FIVE

Sample Preparation and Presentation

The MiniScan EZ spectrophotometer is a versatile color measurement instrument than can be used on products of virtually any size, in industries as diverse as paint and textiles. Because of its compact design, it can be used to measure objects that would be difficult to position at the sample port of a larger color instrument. However, careful attention to proper sample presentation and presentation is required for consistent and accurate color measurements.

It is important to select samples appropriately, use an established measurement method, and handle all samples in a consistent manner. The guidelines in this chapter will help you while taking measurements.

Selecting Samples

Choose samples that are representative of the material used. If samples are non-representative of the batch or are spoiled, damaged, or irregular, then the result may be biased. When choosing a sample, select randomly and examine the sample to avoid biased results. If your sampling procedure is adequate, another sample

selected from the same batch should result in comparable measured values.

Preparing Samples

Prepare samples in exactly the same manner each time they are measured. Follow standard methods if they exist, such as ASTM or TAPPI methods.

Sample Presentation

Present the samples to the instrument in a standard, repeatable manner. Results obtained depend on the condition of the samples and their presentation. If you establish a method so that the same procedure is used each time specific samples or types of samples are measured, then you will have a valid basis for comparison of measured results. This also ensures repeatability of results when measuring the same sample. Make a checklist so that operators may simply check each step. The checklist will also help in the training of new operators.

There are variety of techniques that can be used in handling various forms of objects and materials so that the most valid and repeatable measurement of their appearance results. For example, when measuring the color of a sample, such as fabric, that is translucent, the sample should be folded into multiple layers to make it appear more opaque. Other materials, such as liquids or semi-solids, might be read through the glass of a sample cup, which presents a flat surface to the instrument.

When taking readings, make sure that the MiniScan EZ sample port is flat against the sample surface. This may be difficult if the sample is curved or irregularly shaped. Look at the instrument from all angles to make sure the port makes as

much contact as possible with the product. When measuring thin, soft materials (such as fabric or paper) place a hard, flat surface behind the product to ensure proper contact with the sample port and to ensure that it does not pillow into the sample port. Average several readings when measuring samples that are textured, patterned, or irregular in color.

Examples of ways to measure several types of samples are given below.

Directional Samples

Directionality can be minimized by averaging several measurements with rotation of the sample between readings. Examination of the standard deviation displayed with the averaging function can guide you in selecting the appropriate number of readings to average.

Non-opaque Samples

Non-opaque samples must have consistent backings. A white uncalibrated tile is recommended. If the sample is such that it can be folded to give multiple layers, such as tissue or fabric, the number of layers for each sample should be noted.

Translucent Samples

Light trapped in a translucent sample can distort the color. The thickness of the sample presented should be chosen to maximize the haze or color difference and the sample should be backed with a white tile, if possible, to eliminate the effects of ambient (room) light.

CHAPTER SIX

Maintaining and Testing MiniScan EZ

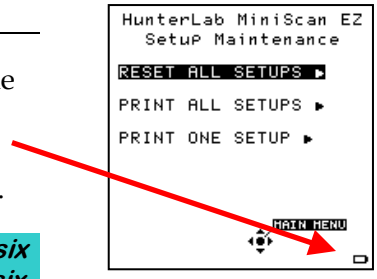
The MiniScan EZ requires very little maintenance; just recharge/replace the batteries as needed, keep the tiles, black glass, and light trap clean, and take reasonable precautions to prevent entry of contaminants into the sample port.

This chapter describes the maintenance necessary to keep your instrument functioning properly and tests that you may run to assess its performance.

Notice: The MiniScan EZ contains hazardous voltages and no user-replaceable parts. It should be disassembled only by HunterLab personnel.

Recharging/Replacing the Batteries

When the battery level indicator on the MiniScan EZ screen has decreased to outline only, you should replace the batteries with fresh or recharged ones.



Notice: The MiniScan EZ can use six standard AA alkaline batteries or six rechargeable AA NiMH batteries. Do not mix battery types in the instrument. To recharge the NiMH

batteries, remove them from the instrument and recharge them using the supplied charger.

Cleaning the MiniScan EZ

Clean the outside surfaces of the MiniScan EZ using a soft cloth. Do not spray liquids directly on the instrument.

Maintaining the Instrument Standards

Before you standardize the MiniScan EZ each time, inspect the white tile and black glass (if included) for dust and fingerprints. If you have a light trap, inspect it for dust and scratches. Do the same for the green tile prior to running the green tile test. Keep the calibration cylinder closed and in the carrying case when it is not being used. If a tile is lost or damaged, contact HunterLab as described in "When You Need Assistance" concerning replacement.

Clean the tiles and black glass using a soft nylon bristle brush and a solution of warm water and a laboratory grade detergent such as SPARKLEEN. Rinse the tiles in a stream of warm tap water. Blot them dry using a clean, non-optically brightened, lint-free paper towel.

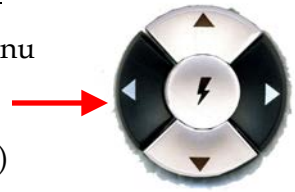
Note: SPARKLEEN is manufactured by Fisher Scientific Co., Pittsburgh, PA 15219 and may be ordered from them using catalog number 4-320-4. One tablespoon of SPARKLEEN should be added to every gallon of water.

Replacing the Lamp

Lamp replacement requires a trained technician. Contact the HunterLab Field Service Department to arrange for lamp replacement. Please read "When You Need Assistance," page 8-7, prior to contacting HunterLab.

Diagnostics

Diagnostics is selected from the main menu by moving the cursor highlight to its position using the up and down arrow buttons and then pressing the center (Go) button. The Diagnostics menu appears.



Choose the desired function by scrolling using the up and down arrow buttons until it is highlighted and then pressing the right arrow button. The various functions perform as described below.

White Repeatability ▸

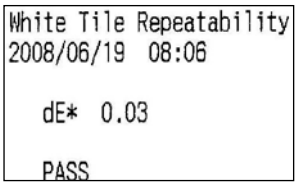
The White Repeatability screens first prompt you through a normal standardization for the instrument. When standardization is complete, you are then prompted to leave the white tile in position at the sample port and to press the center button (Go).

Twenty readings of the white tile are made automatically and the results of each reading shown as it is made. You may cancel the test at any time by pressing Cancel.

When all readings are complete, the final result, as well as whether the instrument passes or fails the test, is shown. The specification is that dE* must be less than

or equal to 0.05 for the instrument to pass the test.

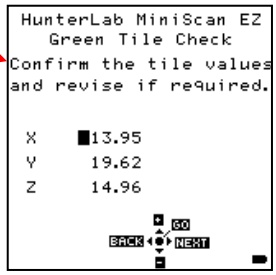
Press Print to print the result (if a printer is connected to the instrument's USB port). An example printout is shown below.



Press Diags Menu to return to the Diagnostics menu.

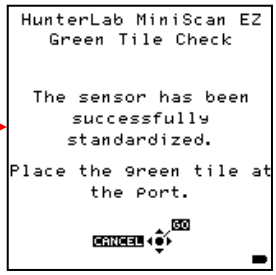
Press Main Menu to return to the main menu.

Green Tile Check ▸



The first Green Tile Check screen allows you to compare the values in your MiniScan EZ's memory to the values read at factory on the back of your green check tile. If the values match, press the center button (Go) to continue. If the values in the instrument's memory require revision, change the highlighted digit of the selected color scale value using the up and down arrow buttons. When the desired digit is shown, press Next to move to the next digit. When all digits are as desired, press Go to continue. You may also press Back to cancel the test.

You are next prompted through a normal standardization for the instrument. When standardization is complete, you are then prompted to place the green tile at the sample port and to press the center button (Go).



One reading of the green tile is made, and then the final result, as well as whether the instrument passes or fails the test, is shown. The specification is that dX, dY, and dZ must all be less than or equal to 0.30 for the instrument to pass the test.

Press Print to print the result (if a printer is connected to the instrument's USB port).

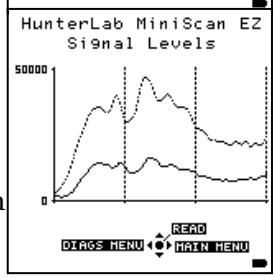
Press Diags Menu to return to the Diagnostics menu.

Press Main Menu to return to the main menu.

Signal Levels ▸

The Signal Levels diagnostic first prompts you to place a sample at the measurement port. Normally this will be the white tile, but you may be instructed otherwise by HunterLab's Technical Support staff. Place the sample and press Go.

The sample and monitor channels are plotted on a graph for examination by HunterLab's Technical Support staff.



The purpose of this test is to verify that both the sample and monitory signal levels are within the correct operating range and to see channel drop-outs should any occur.

Press Read to read again.

Press Diags Menu to return to the Diagnostics menu.

Press Main Menu to return to the main menu.

Self Test ▸

The DIAGNOSTICS MENU contains a fourth function named SELF TEST. When this function is selected, communications tests between the MiniScan EZ's subsystems are run. If successful, the versions of the firmware present would be displayed. Also shown is the value of the checksum of the instrument's calibration data as four hexadecimal digits.

The value of the checksum of the calibration data should remain constant unless the white tile's assigned reflectance is updated or the instrument is serviced. You should keep a record of the checksum's value. If it changes for unexplained reasons then the instrument may not function correctly.

Press Diags Menu to return to the Diagnostics menu.

Press Main Menu to return to the main menu.

CHAPTER SEVEN

Specifications

The specifications and characteristics of your instrument are given in this chapter.

Note: Every attempt at accuracy is made, but specifications are subject to change without notice.

For best performance, your instrument should be placed where there is ample work space with medium or subdued illumination and no drafts. The operating conditions (temperature and humidity ranges) are given in the Operating Conditions section below.

Operating Conditions

MiniScan EZ can be stored in an area with a temperature range of -5°F to 150°F (-20°C to 65°C) for up to 3 weeks and can be operated under temperature conditions of 50°F to 104°F (10°C to 40°C). For specification-level performance, the recommended temperature range is 70-82°F (21-28°C). It may be operated under relative noncondensing humidity conditions of 10% to 90%. Do not leave MiniScan EZ in an area where temperature or humidity extremes are possible.

Physical Characteristics

Weight	2.25 lb (1 kg)
Dimensions	5.5" high x 4.3" wide x 10.5" long (14 cm x 11 cm x 26.7 cm)
Communications Interface	USB to computer or printer
RFI Compliance	FCC Class A (Commercial), IEC, or equivalent
Safety Compliance	UL, CSA, IEC, or equivalent

Conditions of Illumination and Viewing

Light Source	Pulsed xenon
Source UV Content	Match to D65 with CIE rating of CC or better
Lamp Life	>1 million flashes
45°/0° Illumination	Circumferential using a cylindrical mirror
Integrating Sphere (diffuse/8° instruments only)	2.5 inch (63.5 mm) diameter, coated with SpectraFlect
Detection	2-channel polychromator with 256-element scanned array (half for sample channel, half for monitor)
Port Diameters/ View Diameters	
45°/0°	LAV: 1.25″ (31.8 mm)/1″ (25 mm) SAV: 0.25″ (6 mm)/0.20″ (5 mm)
Diffuse/8°	LAV: 1″ (25 mm)/0.8″ (20 mm) SAV: 0.6″ (14.3 mm)/0.3″ (8 mm)

System Power

Power Input	Disposable or rechargeable AA batteries
Battery Life	>4,000 readings per charge

Instrument Performance

Spectral Data	Range: 400-700 nm Reporting Interval every 10 nm
Bandwidth at Half-height	10 nm
Wavelength Accuracy	≤0.75 nm
Photometric Range	0-150% reflectance
Photometric Resolution	0.01% reflectance
Measurement Speed (at 23°C)	≤1.5 seconds
Measurement Storage Capacity	750 readings 100 product setups

Regulatory Notice

A copy of the Declaration of Conformity according to ISO/IEC Guide 22 and EN 45014 follows.

DECLARATION OF CONFORMITY
according to ISO/IEC Guide 22 and EN 45014

Manufacturer's Name:	Hunter Associates Laboratory, Inc.
Manufacturer's Address:	11491 Sunset Hills Road Reston, Virginia U.S.A. 20190
Declares that the Product:	
Product Name:	MiniScan EZ
Model:	**MSEZ-4500L, MSEZ-4500S, MSEZ-4000L, MSEZ-4000S.**

Conforms to the following Standards:

IEC 61326-1:2005 (CISPR 11:2003:A1:2004, EN 61000-4-2:1995, and EN 61000-4-3:2006 + A1:2008)

EN 61010-1:2001

Supplementary Information:

This product herewith complies with the requirements of the EMC Directive 2004/108/EC and Council Directive 98/34/EEC, and carries the CE mark accordingly.

(1) This product was tested using an IBM-compatible computer.

European Contact: *Your local Hunter Associates Laboratory representative or*
Christian Jansen
Griesbraeustrasse 11
82418 Murnau
Germany
Telephone: +49 (0) 8841 9464
Fax: +49 (0) 8841 99472

CHAPTER EIGHT

Instrument Replacement, Repair, Problems, and Questions

The following HunterLab policies are described in this chapter:

- Warranty
- Shipping claims
- Returns/service
- Technical assistance.

Warranty

HunterLab warrants that all instruments it manufactures will be free from defects in material and workmanship under normal use and service. Our obligation under this warranty is limited to repairing or replacing any parts which our examination disclose to have been factory defective when returned to us by prepaid transportation. The time limit on this warranty is one year from date of shipment of new instruments and two months from the date of shipment of repaired instruments.

HunterLab warranty does not cover expendable items such as lamps, fuses, batteries, and diskettes. The warranty is void if the user has made unauthorized repairs, performed improper installation, or has incorrectly used the instrument.

Shipping Claims

All materials are sold F.O.B. from Reston, Virginia (unless otherwise specified) and HunterLab responsibility ends upon delivery to the first carrier. All claims for loss or damage must be rendered by the consignee against the carrier within fifteen days of receipt of goods. A copy of this notice must also be forwarded to HunterLab within five days of its receipt.

Breakage or Damage

According to the contract terms and conditions of the carrier, the responsibility of the shipper ends at the time and place of shipment. The carrier then assumes full responsibility. Perform the following procedures in the case that your instrument arrives broken or damaged.

Freight or Express

1. Notify your local carrier.
2. Hold the damaged goods with their container and packaging for inspection by the examining agent. Do not return any goods to HunterLab prior to inspection by and authorization of the carrier.
3. File a claim against the carrier. Substantiate this claim with the examining agent's report. A certified copy of our invoice is available upon request. The original B/L is attached to our original invoice. If the shipment is prepaid, write for a receipted transportation bill.
4. Advise HunterLab regarding replacement.

Parcel Post Shipment

1. Notify HunterLab at once in writing, giving details of the loss or damage. This information is required for filing a claim.
2. Hold the damaged goods with their container and packaging for possible inspection by postal authorities.
3. Advise HunterLab regarding replacement.

United Parcel Service

1. Contact your local UPS office regarding damage and insurance claims. Each UPS office has a different method of handling these occurrences and yours will advise you of its procedures.
2. Retain the container and packaging.
3. Notify HunterLab at once for replacement.

Shortage

Perform the following procedure if your order appears to be missing items.

1. Check the packing list notations. The apparent shortage may be a backordered item and may be marked as an intentional short-ship.
2. Re-inspect the container and packing material, particularly to locate smaller items.
3. Ascertain that the item was not removed by unauthorized personnel prior to complete unpacking and checking.
4. Notify HunterLab immediately of the shortage in writing.

Incorrect Shipment

Perform the following procedure if material received does not correspond with your order.

1. Notify HunterLab immediately, referencing your order number and item.
2. Hold incorrect items until return shipping instructions are received.

Note: Unless the procedures described in this section are followed and HunterLab is notified within fifteen days, we cannot accept responsibility for damaged or incorrect items.

Returns/Repairs

A service request order (SRO) number is required before any items can be returned to HunterLab. Contact HunterLab's Order Processing Department to obtain an SRO for damaged or incorrect parts, or Technical Support to obtain an SRO to return and instrument for service.

Do not return any damaged or incorrect items until all shipping instructions are received.

HunterLab offers complete repair services for all instruments it manufactures. Call HunterLab for the service facility nearest your location. If your equipment is not functioning properly, contact HunterLab Technical Support for maintenance or repair instructions. Many times, this on-the-spot diagnosis is all that is required.

If repair is required, the instrument may be returned to a HunterLab service facility. For schedule and terms for repairs, call HunterLab Technical Support. Please read the next section, "When You Need Assistance," prior to contacting HunterLab.

Customers are responsible for incoming and outgoing freight charges for instrument returned to HunterLab for all repairs, including warranty repairs.

Packing and Shipping Instruments for Repair

Please regard the following instructions when packing your instrument to return it to HunterLab for repair. **Proper packing is crucial.** These instructions do not replace the recommended professional packaging for your instrument, but may assist in eliminating the need for a shipment claim due to faulty packaging. Purchasing freight insurance does not guarantee a successful

damaged shipment claim if the carrier determines the instrument was not packaged properly.

- All instrument tiles, black glass or light trap, power supply, power cords, and cables for the instrument should be included in your shipment. **Your repair estimate will be delayed if the instrument tiles are shipped separately later.**

- Cover the measurement port. **Do not use duct tape.** "Painter's tape" is preferred, as it will not leave residue on the instrument.

- MiniScan EZ carrying cases are not intended as shipping containers. Place the instrument inside the carrying case and then place the carrying case into a new carton which includes, at a minimum, **6 inches of packing material** (preferably foam) around the instrument. Styrofoam peanuts should not be sued as packing material for instruments, as they can suspend items weighing only up to 5 pounds. Observe the information listed on the bottom of most cartons with regard to burst strength and gross weight limits. Single wall cardboard cartons should not be used. (A proper packing carton with packing material may be purchased from HunterLab, if desired.)

- Insure the shipment.

- Provide an itemized packing list of all contents of the shipment.

- Label the carton(s) as follows:

  HunterLab
  Attn: SRO #_____
  11491 Sunset Hills Road
  Reston, VA 20190
  U.S.A.

When You Need Assistance

When you have a problem with an instrument or software, or need technical advice concerning a specific application, you may contact HunterLab for assistance. In order to help us help you, please have the following information available prior to contacting HunterLab:

1. The type of sensor for which you need assistance (MiniScan EZ and geometry).
2. The serial number of the instrument on the bottom of the unit.
3. The type of processor or software you are using the access the sensor output (such as EasyMatch QC), the version of the software and the operating system.
4. The specific nature of the problem, including the exact error message received or the number of units the sensor reads "off" from the standard tiles.
5. Steps already performed to reconcile the problem and/or results of any diagnostic tests.
6. The type of product being measured.
7. Environmental conditions under which the instrument is normally used (temperature, humidity, dust, fumes, etc.)
8. Whether the instrument has recently been moved or the computer reconfigured.
9. The name(s) of any HunterLab personnel with whom you have previously discussed the problem.

The general number for HunterLab is (703) 471-6870. To place an order or for prices on instrument, software, or replacement parts, ask for the ORDER PROCESSING DEPARTMENT. For measurement advice, for help in correcting instrument or software problems, to return instruments to HunterLab for service, or to ask questions about the servicing or recalibration of instruments, as for TECHNICAL SUPPORT.

HunterLab may also be contacted through its web site, www.hunterlab.com.

The mailing address for HunterLab headquarters is given below. Customers outside the United States should contact their HunterLab distributor for initial assistance.

Hunter Associates Laboratory, Inc.
11491 Sunset Hills Road
Reston, Virginia 20190
U.S.A.

CHAPTER NINE

Measurement Values

Color values measured using the MiniScan EZ are relative to the absolute value or a perfect reflecting diffuser as measured under the same geometric conditions (see ASTM E308), according to the January 1, 1969 recommendation of the International Commission on Illumination, CIE.

This chapter explains the various color scales and indices available for display using the MiniScan EZ.

Absolute Color Scales (available when Display Type is Absolute)

CIE Tristimulus Values, XYZ

The MiniScan EZ performs integration of reflectance values over the visible spectrum to arrive at tristimulus X, Y, and Z values. These values simulate the color matching response functions of the human observer as defined by the 1931 2° Standard Observer or the 1964 CIE 10° Standard Observer. Tristimulus integrations based on any of the illuminants listed on the next page may be performed. For a complete description of how to calculate tristimulus values, refer to the publication CIE 15.2 and to ASTM E308.

CIE Chromaticity Coordinates, Yxy

The relationship between CIE XYZ and the x, y, chromaticity coordinates is as follows:

Y = CIE Tristimulus Y

$$x = \frac{X}{X + Y + Z}$$

$$y = \frac{Y}{X + Y + Z}.$$

Opponent Color Scales: Hunter L, a, b, CIE L*a*b*, and CIE L*C*h

The opponent-color scales yield measurements of color in units of approximate visual uniformity throughout color space.

In the **Hunter L, a, b** scale, L measures lightness and varies from 100 for perfect white to zero for black, approximately as the eye would evaluate it. The chromaticity dimensions (a and b) yield understandable designations of color as follows:

a describes redness when positive, gray when zero, and greenness when negative.

b describes yellowness when positive, gray when zero, and blueness when negative.

The relationship between the Hunter L, a, b scale and the CIE XYZ scale for the CIE 1931 2° Standard Observer and the CIE 1964 10° Standard Observer is as follows:

$$L = 100\sqrt{\frac{Y}{Y_n}}$$

$$a = K_a \frac{X/X_n - Y/Y_n}{\sqrt{Y/Y_n}}$$

$$b = K_b \frac{X/X_n - Z/Z_n}{\sqrt{Y/Y_n}}$$

where:

X, Y, and Z are CIE tristimulus values

X_n, Y_n, and Z_n are tristimulus values of the standard illuminant as listed in ASTM E308 with Y_n always equal to 100.00 (normalized)

K_a and K_b are chromaticity coefficients for the illuminant used (see ASTM E308).

Illuminant A represents incandescent (tungsten) lamp light with an approximate color temperature of 2854K.

Illuminant C represents average, or north sky, daylight with a correlated color temperature of approximately 6770K.

Illuminant D50 represents daylight with a correlated color temperature of approximately 5000K.

Illuminant D55 represents daylight with a correlated color temperature of approximately 5500K.

Illuminant D65 represents daylight with a correlated color temperature of approximately 6500K.

D75 represents daylight with a correlated color temperature of approximately 7500K.

Illuminants F2, F7, and F11 represent light from a cool white fluorescent source.

The **CIE 1976 L*a*b*** scale is recommended by the Commission Internationale de l'Eclairage (CIE). It is a simplified cube root version of the Adams-Nickerson space produced by plotting the quantities of L*a*b* in rectangular coordinates.

The relationship between the CIE L*a*b* scale and the CIE XYZ scale for any illuminant referenced in ASTM E308 is as follows:

$$L^* = 116\ f\left(\frac{Y}{Y_n}\right) - 16$$

$$a^* = 500\left[\ f\left(\frac{X}{X_n}\right) - f\left(\frac{Y}{Y_n}\right)\right]$$

$$b^* = 200\left[f\left(\frac{Y}{Y_n}\right) - f\left(\frac{Z}{Z_n}\right)\right]$$

where:

$$f\left(X/X_n\right) = \sqrt[3]{X/X_n} \qquad \text{if } X/X_n > (24/116)^3$$

$$f\left(\frac{X}{X_n}\right) = \left(841/108\right)\left(\frac{X}{X_n}\right) + \frac{16}{116} \qquad \text{if } X/X_n \le (24/116)^3$$

$$f\left(Y/Y_n\right) = \sqrt[3]{Y/Y_n} \qquad \text{if } Y/Y_n > (24/116)^3$$

$$f\left(\frac{Y}{Y_n}\right) = \left(841/108\right)\left(\frac{Y}{Y_n}\right) + \frac{16}{116} \qquad \text{if } Y/Y_n \le (24/116)^3$$

$$f\left(Z/Z_n\right) = \sqrt[3]{Z/Z_n} \qquad \text{if } Z/Z_n > (24/116)^3$$

$$f\left(\frac{Z}{Z_n}\right) = \left(841/108\right)\left(\frac{Z}{Z_n}\right) + \frac{16}{116} \qquad \text{if } Z/Z_n \le (24/116)^3$$

and X_n, Y_n, and Z_n are tristimulus values for any illuminant.

CIE L*C*h is a modification to the CIEL*a*b* scale, and plots in polar coordinates rather than rectangular ones.

$$L^* = 116 \sqrt[3]{\frac{Y}{Y_n}} - 16$$

$$C^*_{ab} = \sqrt{a^{*2} + b^{*2}}$$

$h° = \arctan (b^*/a^*)$

Reference: Commission Internationale de l'Elclairage (CIE): "Recommendations on Uniform Color Spaces, Color Difference Equations, Psychometric Color Terms," Supplement no. 2 to CIE Publication No. 15, *Colorimetry*, Bureau Central de la CIE, Paris, 1978. For more information, see AATCC Test Method 173: *Calculation of Small Color Differences*.

Difference Color Scales (available when Display Type is Difference; Reading of Both Standard and Sample Required)

dXdYdZ

This scale yields the color difference between the sample and the standard via the CIE XYZ scale.

$dX = X_{sample} - X_{standard}$

$dY = Y_{sample} - Y_{standard}$

$dZ = Z_{sample} - Z_{standard}$.

dYdxdy

This scale yields the color difference between the sample and the standard via the CIE Yxy scale.

$dY = Y_{sample} - Y_{standard}$

$dx = x_{sample} - x_{standard}$

$dy = y_{sample} - y_{standard.}$

dLdadb

This scale yields the color difference between the sample and the standard via the Hunter L, a, b scale.

$dL = L_{sample} - L_{standard}$	(If dL is positive, the sample is lighter than the standard. If dL is negative, the sample is darker than the standard.)
$da = a_{sample} - a_{standard}$	(If da is positive, the sample is redder than the standard.

If da is negative, the sample is greener than the standard.)

$db = b_{sample} = b_{standard}$ (If db is positive, the sample is yellower than the standard. If db is negative, the sample is bluer than the standard.)

dL*da*db

This scale yields the color difference between the sample and the standard via the CIE L*a*b* scale.

$dL^* = L^*_{sample} - L^*_{standard}$

$da^* = a^*_{sample} - a^*_{standard}$

$db^* - b^*_{sample} - b^*_{standard}$

For more information, see AATCC Test Method 173: *Calculation of Small Color Differences*.

dL*dC*dH*

This scale yields the color difference between the sample and the standard via the CIE L*C*h scale.

$dL^* = L^*_{sample} - L^*_{standard}$

$dC^* = C^*_{sample} - C^*_{standard}$

$dH^* = h°_{sample} - h°_{standard}$

where

If $h°_{sample} > h°_{standard}$, then dH* is regarded as positive.

If $h°_{standard} > h°_{sample,}$ then dH* is regarded as negative.

Absolute Indices (available when Display Type is Absolute)

457-nm Brightness

457-nm brightness (displayed as 457B) can be used to indicate the relative brightness of paper. 457-nm brightness is calculated over the range of 400 nm to 510 nm in accordance with TAPPI document T452.

Tint ASTM E313

ASTM E313 Tint (displayed as Tint) is calculated as follows:

$$\text{Tint E313} = 1000\left(x_n - x\right) - 650\left(y_n - y\right)$$

when the 2° observer is in use

and

$$\text{Tint E313} = 900\left(x_n - x\right) - 650\left(y_n - y\right)$$

when the 10° observer is in use

Where x_n and y_n are the chromaticity coordinates for the CIE illuminant and standard observer used. These values are provided in the table given in ASTM E313. This index is only displayed when the data view is configured for either the C or the D65 illuminant, as these are the only relevant illuminants.

A few caveats regarding measurement of tint:

- The application of this equation is restricted to samples that are called "white" commercially, that are similar in color and fluorescence, and that are measured on the same instrument at the same time. Under these conditions, their use should give relative, but not absolute, evaluations of tint that are adequate for commercial use.

- The more positive the value of tint, the greater is the indicated greenish tint of the sample. The more negative the value of

  tint, the greater is its reddish tint. Lines of equal tint are approximately parallel to the line of dominant wavelength 466 nm. For the perfect reflecting diffuser, tint = 0.

- Equal differences in tint do not always represent equal perceptual differences in tint.

- This equation should only be used for samples having tint values between -3 and +3.

Whiteness Index

Whiteness is associated with a region or volume in color space in which objects are recognized as white. Degree of whiteness is measured by the degree of departure of the object from a *perfect* white.

Whiteness Index E313 (displayed as WIE) is the whiteness index published in ASTM Method E313.

$$\text{WI CIE} = Y + 800\,(x_n - x) + 1700\,(y_n - y) = \text{WI-E313}$$

where Y, x, and y are the luminance factor and chromaticity coordinates of the specimen, and x_n and y_n are the chromaticity coordinates for the CIE illuminant and standard observer used. These values are provided in the table given in ASTM E313. This index is only displayed when the data view is configured for either the C or the D65 illuminant, as these are the only relevant illuminants.

Refer to ASTM Method E313, "Standard Practice for Calculating Yellowness and Whiteness Indices from Instrumentally Measured Color Coordinates," for more information.

Y Brightness

Y Brightness (Y) is also known as luminosity or light intensity. This index is calculated in the same way as (and is equivalent to) the Y of the XYZ tristimulus scale.

Yellowness Indices

Visually, yellowness is associated with scorching, soiling, and general product degradation by light, chemical exposure, and processing. Yellowness indices are used chiefly to measure these types of degradation.

Yellowness Index per ASTM Method E313 (displayed as YIE) is calculated as follows:

$$\text{YI E313-96} = \frac{100\left(C_x X - C_Z Z\right)}{Y}$$

Where X, Y, and Z are the CIE tristimulus values and the coefficients depend on the illuminant and observer as indicated in the table given in ASTM E313. This index is only displayed when the data view is configured for either the C or the D65 illuminant, as these are the only relevant illuminants.

Refer to ASTM Method E313, "Standard Practice for Calculating Yellowness and Whiteness Indices from Instrumentally Measured Color Coordinates," for more information.

Yellowness Index per ASTM Method D1925 (displayed as YID) is defined in the MiniScan EZ as follows:

$$\text{YI D1925} = \frac{100\left(1.274641506X - 1.057434092\ Z\right)}{Y}$$

under C/2° conditions.

The yellowness index formula is shown in ASTM D1925 as:

$$\text{YI D1925} = \frac{100\left(1.28\ X_{CIE} - 1.06\ Z_{CIE}\right)}{Y_{CIE}}$$

under C/2° conditions.

The tristimulus values of clear air (for CIE illuminant C and the 1931 CIE 2° standard observer) are X = 98.041, Y = 100.000, Z = 118.103. Using these values, the ASTM formula yields YI = 0.303 for clear air because the factors are truncated to three significant

figures. In order to set the yellowness index for air equal to 0.0, the constant multipliers for X_{CIE} and Z_{CIE} have been expanded slightly in the MiniScan EZ.

The ASTM D1925 method was withdrawn in 1995, but this formula still provides useful information. This index is only displayed when the data view is configured for C/2°, as this is the only relevant illuminant/observer combination.

Paper Brightness (Z%)

Paper brightness, Z%, is used in the evaluation of the degradation of white materials. It can also be a measure of the effectiveness of bleaching.

$$Z\% = \frac{100Z_{CIE}}{Z_n}.$$

Difference Indices (available when Display Type is Difference; Reading of Both Standard and Sample Required)

D457B

This index yields the difference between the sample and the standard via the 457-nm Brightness index.

$$D457B = 457B_{sample} - 457B_{standard}.$$

dTint

This index yields the difference between the sample and the standard via the Tint indices.

$$dTint = Tint_{sample} - Tint_{standard}$$

dWIE

This index yields the difference between the sample and the standard via the Whiteness Index.

$$dWIE = WIE_{sample} - WIE_{standard}$$

dY Brightness

This index yields the difference between the sample and the standard via the Y brightness index.

$$dY = Y_{sample} - Y_{standard}.$$

dYIE and dYID

These indices yield the differences between the sample and the standard via the Yellowness Index E313 and Yellowness Index D1925.

$$dYIE = YIE_{sample} - YIE_{standard}$$

$$dYID = YID_{sample} - YID_{standard}$$

dZ%

This index yields the difference between the sample and the standard via the Z% index.

$$dZ\% = Z\%_{sample} - Z\%_{standard}.$$

Other Indices (available with Absolute and Difference Display Types; Reading of Both Standard and Sample Required)

dE Total Color Difference

The Hunter L, a, b total color difference for any illuminant and observer is calculated as follows:

$$dE = \sqrt{dL^2 + da^2 + db^2} .$$

dE approximates the NBS Unit of Color Difference (Judd-Hunter), which represents the average maximum difference acceptable in a series of dye house commercial matches in 1939.

dC Chromaticity Difference

The Hunter L, a, b chromaticity difference for any illuminant and observer is calculated as follows:

$$dC = \sqrt{da^2 + db^2} .$$

dE* Total Color Difference

CIE dE* total color difference is defined as follows:

$$dE^* = \sqrt{dL^{*2} + da^{*2} + db^{*2}} .$$

dC* Chroma Difference

CIE dC* chroma difference is defined as follows:

$dC^* = C^*_{sample} - C^*_{standard}$ where $C^* = \sqrt{a^{*2} + b^{*2}}$ and is termed metric chroma.

Colorant Strength

When SMA is selected as the index, color values are adjusted based on the wavelength of maximum absorbance (minimum

reflectance) of the standard. The strength value is displayed as a percentage.

$$SMA = (K/S)_\lambda$$

where

$$(K/S)_\lambda = \frac{(1.0 - K_\lambda)^2}{[2.0 * (1.0 - S_\lambda) * (K_\lambda - S_\lambda)]}$$

K_λ = the absorption coefficient of the specimen (the %R value normally measured by a spectrophotometer and normalized to 1.0)

S_λ = the scattering coefficient of the specimen (assumed to be 0.0 for most applications).

SW is K/S weighted by the visual function (such as the XYZ observer functions and the D65 illuminant energy function) and summed over a wavelength interval within the visible spectrum.

$$SW = \sum_\lambda E_\lambda * (K/S)_\lambda * S_\lambda d\lambda$$

where

λ = wavelength over the available range of the spectrophotometer

E = energy distribution of the illuminant being used

S = observer functions.

dEc and CMC Autotolerancing

The equation for dEc describes an ellipsoidal volume with axes in the direction of lightness, chroma, and hue centered about a

standard. When the semi-axis lengths for the ΔEc formula equal the calculated lSL, cSc, and SH values for the standard, the resulting ellipsoid describes a 1.0 dEc unit volume/tolerance.

This volume and the size of its component parts become the basis for the establishment of an appropriately-sized volume of acceptability for a given commercial situation by the application of a commercial factor (cf). The cf equals the dEc tolerance.

When l = 2.0 and c = 1.0, the equation fixes the ratio of the three components (SL:SC:SH) to correlate with visible assessment of typical textile samples. Other values of l may be required in cases where the surface characteristics change dramatically. The value of c is always left at 1.0.

$$dEc = \sqrt{\left(\frac{dL^*}{lSL}\right)^2 + \left(\frac{dC^*}{cSC}\right)^2 + \left(\frac{dH^*}{SH}\right)^2} \qquad \text{Absolute}$$

$$dL^* c = \frac{dL^*}{lSL}$$

$$dC^* c = \frac{dC^*}{cSC}$$

$$dH^* c = \frac{dH^*}{SH}$$

where

L*, C*, and H* are those of the standard unless otherwise specified.

$$SL = \frac{0.040975L^*}{1 + 0.01765L} \qquad \text{for } L^* > 16$$

$$SL = 0.511 \qquad \text{for } L^* < 16$$

$$SC = \frac{0.0638C^*}{1 + 0.0131C^*} + 0.638$$

$$SH = (FT + 1 - F)\, SC$$

$$C^* = \sqrt{a^{*2} + b^{*2}}$$

$$h^\circ = \arctan\left(\frac{b^*}{a^*}\right)$$

$$dL^* = L^*_{SMP} - L^*_{STD}$$

$$dC^* = C^*_{SMP} - C^*_{STD}$$

$$dH^* = \sqrt{dE^{*2} - dL^{*2} - dC^{*2}}$$

$$F = \sqrt{\frac{C^{*4}}{C^{*4} + 1900}}$$

$$T = 0.36 + |0.4 \cos(35 + h)| \quad \text{for } h < 164^\circ \text{ or } h > 345^\circ$$

$$T = 0.56 + |0.2 \cos(168 + h)| \quad \text{for } 164^\circ < h < 345^\circ$$

Tolerances are:

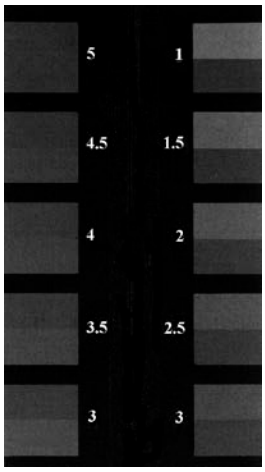
$dL^* = (cf)\, lSL$ $dLc = cf$
$dC^* = (cf)\, cSC$ $dCc = cf$
$dH^* = (cf)\, SH$ $dHc = cf$
$dEc = cf$

For a more detailed description of CMC, refer to "Calculation of Small Color Differences for Acceptability," AATCC Test Method 173-1992, published in the AATCC Technical Manual.

Gray Change

Gray Change indicates the amount of fading or color alteration that occurs with environmental exposure or washing of textiles. The loss of color using the Gray Change Scale is evaluated by comparison to five pairs of gray standards similar to those shown below. One half of each standard is always of identical chroma to the starting specimen. The second half ranges from the starting

chroma (no loss of color) to white (loss of all color). The amount of contrast between the treated and untreated fabric is related to one of the standard pairs to yield the gray scale rating. On this scale, 5 indicates that next to no color was lost, and 1 indicates that most color was lost.



The bottom half of each pair shows the starting color. The top half shows the color of the treated fabric. (Illustration from AATCC Evaluation Procedure 1.)

Gray Change, as implemented, is based on ISO 105-A05:1996, Textiles - Tests for Colour Fastness - Part A05: Instrumental Assessment of Change in Colour for Determination of Grey Scale Rating. This method is equivalent to AATCC Evaluation Procedure 7, "Instrumental Assessment of Change in Color of a Test Specimen." It is intended as an alternative to visual assessment as described in ISO 105-A02: 1993, Textiles - Tests for Colour Fastness - Part A02: Grey Scale for Assessing Change in Colour, or AATCC Evaluation Procedure 1, "Gray Scale for Color Change," and is generally used in color fastness testing. It may be used in assessing any samples except those which have been treated with fluorescent whitening agents (FWAs).

$$dE_F = \sqrt{dL^{*2} + dC_F^{*2} + dH_F^{*2}}$$

where

$$dH_F = \frac{dH_K}{1 + (10C_M/1000)^2}$$

$$\Delta C_F = \frac{\Delta C_K}{1 + (20C_M/1000)^2}$$

$dH_K = dH^*_{ab} - D$

$dC_K = dC^*_{ab} - D$

$$D = \frac{dC^*_{ab}\, C_M\, e^{-x}}{100}$$

$$x = \left[\frac{h_M - 280}{30}\right]^2 \qquad \text{if } |h_M - 280| \le 180$$

$$x = \left[\frac{360 - |h_M - 280|}{30}\right]^2 \qquad \text{if } |h_M - 280| > 180$$

$$C_M = \frac{C_{abT} + C^*_{abO}}{2}$$

$$h_M = \frac{h_{abT} + h_{abO}}{2} \qquad \text{if } |h_{abT} - h_{abO}| \le 180$$

$$h_M = \frac{h_{abT} + h_{abO}}{2} + 180 \qquad \text{if } |h_{abT} - h_{abO}| > 180 \text{ and } |h_{abT} + h_{abO}| < 360$$

$$h_M = \frac{h_{abT} + h_{abO}}{2} - 180 \qquad \text{if } |h_{abT} - h_{abO}| > 180 \text{ and } |h_{abT} + h_{abO}| \ge 360$$

L^*_T, C^*_{abT}, h_{abT} = lightness, chroma, and hue of Test specimen

L^*_O, C^*_{abO}, h_{abO} = lightness, chroma, and hue of Original

$dL^* = L^*_T - L^*_O$

$dC^*_{ab} = C^*_{abT} - C^*_{abO}$

sign of ΔH^*_{ab} = sign of $(h_{abT} - h_{abO})$

$$dH^*_{ab} = \sqrt{dE^*_{ab}{}^2 - dL^{*2} - dC^*_{ab}{}^2}$$

$$dE^*_{ab} = \sqrt{dL^{*2} + da^{*2} + db^{*2}}$$

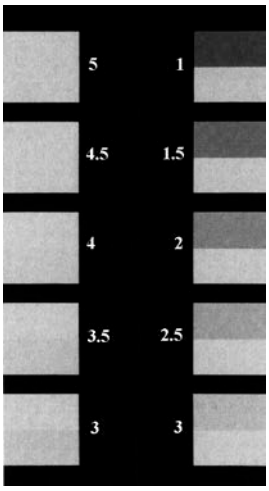
dE_F is used to calculate Gray Change using the equations below:

$$GSC = 5 - \frac{dE_F}{1.7} \qquad \text{if } dE_F \le 3.4$$

$$GSC = 5 - \frac{\log\left(dE_F / 0.85\right)}{\log(2)} \qquad \text{if } dE_F > 3.4.$$

Gray Stain

The transference of color from the test specimen to an adjacent specimen is evaluated in a manner very similar to that of Gray Change. Again, five standard pairs are used. One half of each standard is white, and the second half range ranges from white (no staining) to a gray with the chroma value of the test specimen (great deal of staining). A value of 5 corresponds to virtually no staining, whereas 1 indicates poor color fastness.



The bottom half of each pair shows the starting color of the adjacent fabric. The top half shows the color of the treated adjacent fabric. (Illustration from AATCC Evaluation Procedure 2).

Gray Stain, as implemented, is based on ISO 105-A04:1989, Textiles- Tests for Colour Fastness - Part A04: Method for the Instrumental Assessment of the Degree of Staining of Adjacent Fabrics. It is intended as an alternative to visual assessment as described in ISO 105-A03: 1993, Textiles - Tests for Colour

Fastness - Part A03: Grey Scale for Assessing Staining, or AATCC Evaluation Procedure 2, "Gray Scale for Staining," and is used to assess the degree of staining of adjacent fabrics in a color fastness test.

$$dE_{GS} = dE^* - 0.4\sqrt{dE^{*2} - dL^{*2}}$$

Use dE_{GS} to calculate the GSS as follows:

$GSS = 6.1 - 1.45 \ln (dE_{GS})$ for Ratings 1 to 4.

If the GSS calculated by the above equation is greater than 4, recalculate using the following equation:

$GSS = 5 - 0.23dE_{GS}$ for Ratings 4 to 5.

Metamerism Index

In order to display metamerism index, two data views must be configured in your product setup that contain different illuminant/observer combinations.

The Metamerism Index is designed to indicate the degree to which two items which match under one illuminant no longer match under a second illuminant. The formula for deriving the index is:

$$MI = \sqrt{(dL_{n1} - dL_{n2})^2 + (da_{n1} - da_{n2})^2 + (db_{n1} - db_{n2})^2}$$

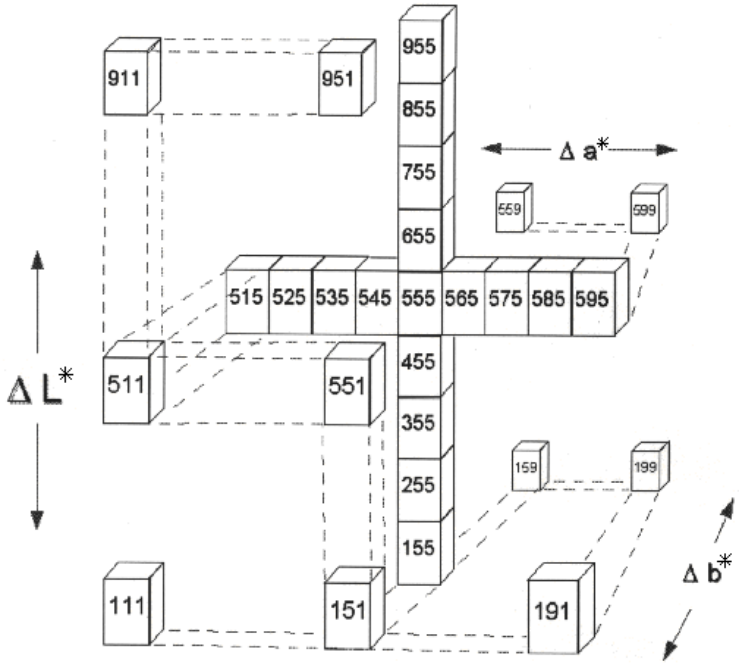
where n1 is the original illuminant and n2 is the illuminant selected in the product setup using the Duplicate standard type.

Shade Number

The shade number, SSN, that can be obtained using your MiniScan EZ provides a convenient way of sorting samples into groups (or "blocks") of similar color. This is helpful in situations where several separate pieces will be combined into a whole and the colors of the pieces must be closely matched.

In order to use shade sorting, you must first read an ideal product standard into your setup preferably as a PHYSICAL standard, and your first data view must be displaying the L*a*b*, L, a, b, or dLdCdH color scale. Then enter your desired tolerances into the setup as well. These tolerances will provide the borders on which your shade number blocks will be based. CMC autotolerancing may be used to calculate these tolerances if desired, but manually-entered rectangular tolerances work just as well. Then, on the CMC/Shade Sort screen, enter the number of shade blocks you wish to have fit inside your tolerance borders. Choices available are 1, 3, 5, 7, and 9. There are nine shade blocks within the acceptable limits (able to be displayed) for each dimension (L*a*b*), so there are 729 possible shade number assignments. Any sample that falls outside the displayable limits is indicated

not with numbers, but with a + or -, depending on whether the actual shade number should be higher than 9 or lower than 1.



The illustration shown above uses the L*a*b* color scale. The middle shade block, 555, is where the standard is located. The first 5 denotes L*, the second 5 denotes a*, and the third 5 denotes b*. The tolerance values are indicated as ΔL*, Δa*, and Δb*. There are five shade blocks on either side of the standard (including the standard's block) on the L* axis, five on either side of the standard on the a* axis, and five on either side of the standard in the b* direction. Suppose we wish to use five shade blocks. Not all of the shade blocks shown on the drawing (from 111 to 999) fall within the established tolerance. Five blocks for each parameter (L*, a*, and b*) do fall within the tolerance range. For the L* parameter, these will be blocks labeled 3-7 for the L* number. For the a* parameter, these will be blocks labeled 3-7 for the a*

number. For the b* parameter, these will be blocks labeled 3-7 for the b* number. Thus, the 345 shade block would be within the tolerance range, but the 245 shade block would be too dark.

Continuing with our example given above, suppose the entered tolerance for each parameter is ±1 unit. That is, ΔL* = 1, Δa* = 1, and Δb* = 1. Thus, with five shade blocks, the center (standard) block extends 0.2 units (1 unit divided by 5) in each direction. The size of this block (and, in fact, each block) is 0.4 units high, 0.4 units wide, and 0.4 units deep (±0.2 units times 2 directions for each parameter).

Once the ΔL*, Δa*, Δb* difference between the sample and the product standard has been established, a shade number can be assigned to the sample. A sample that is very close to the standard in a* and b*, but has values that put it one shade block away for L* would be assigned a shade number of 655 (if lighter than the standard) or 455 (if darker than the standard). Although this sample's color is slightly "off" from the standard, it will be a good match with any other samples in the same shade block and may still be used with these samples.

The number of shade blocks used can be varied using MiniScan XE Plus. If fewer shade blocks are used with the same tolerance (e.g., 3 blocks rather than 5), fewer blocks will be required to fit into the tolerance and each block will be bigger. You may wish to lower the number of shade blocks if you find that your shade block tolerances are too tight. If more shade blocks are used with the same tolerance (e.g., 7 or 9 blocks rather than 5), more blocks will be required to fit into the tolerance and each block will be smaller. You may wish to increase the number of shade blocks if you find that your shade block tolerances are too loose.

Opacity (available with Absolute and Difference Display Types; Working Standard Required)

Opacity (OP) measurements determine opacity by a contrast ratio measurement. The Y value of the sample backed by black is divided by the Y value of the sample backed by white. The resulting fraction is Y%, or opacity, which is calculated as follows:

$$\text{Opacity (Y)} = \frac{Y_{\text{black backing}}}{Y_{\text{white backing}}} \text{ x } 100 \cdot$$

You will be prompted to make two separate readings before an opacity value is displayed.

APPENDIX

Utility Software

Introduction

The MiniScan EZ Utility Software is a 32-bit Windows program that allows the user to standardize the instrument, measure, and archive and restore product setups. Since the MiniScan EZ may be operated using only the keypad buttons and the LCD display, use of the Utility Software is not required. However, the software may be useful for those advanced users who wish to share data with a computer.

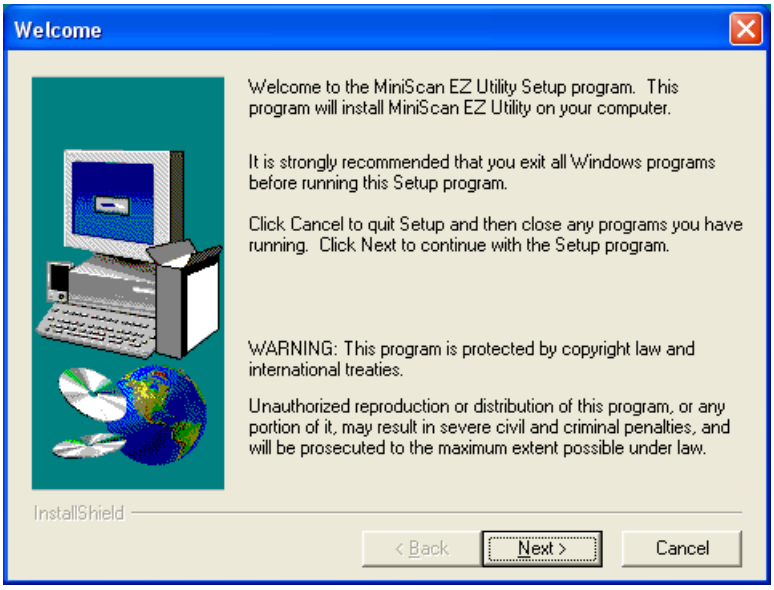
Installation

The Utility Software is shipped on a CD. Complete the steps below to install the software.

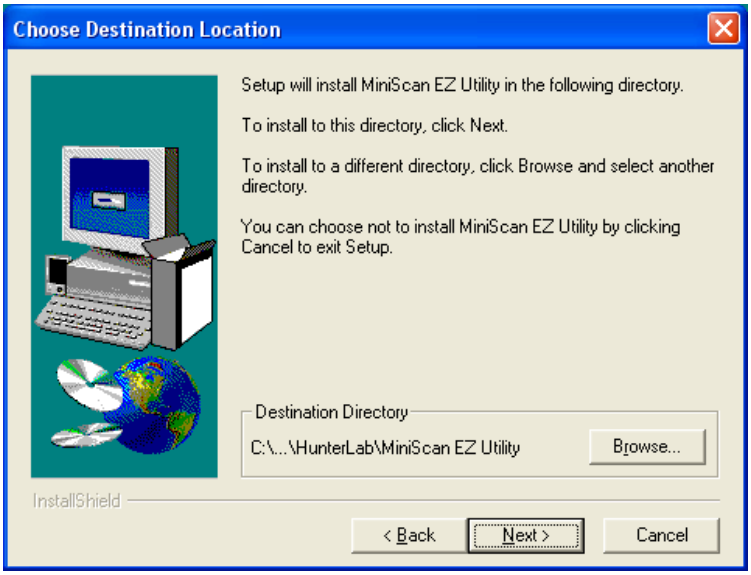
1) Insert the Installation Disk MSEZ Utility s/w into the CD disk drive of the computer.

2) If the installation program does not start automatically, click on **Start**, select **Run**, browse the CD-ROM and open the **SETUP** Application.

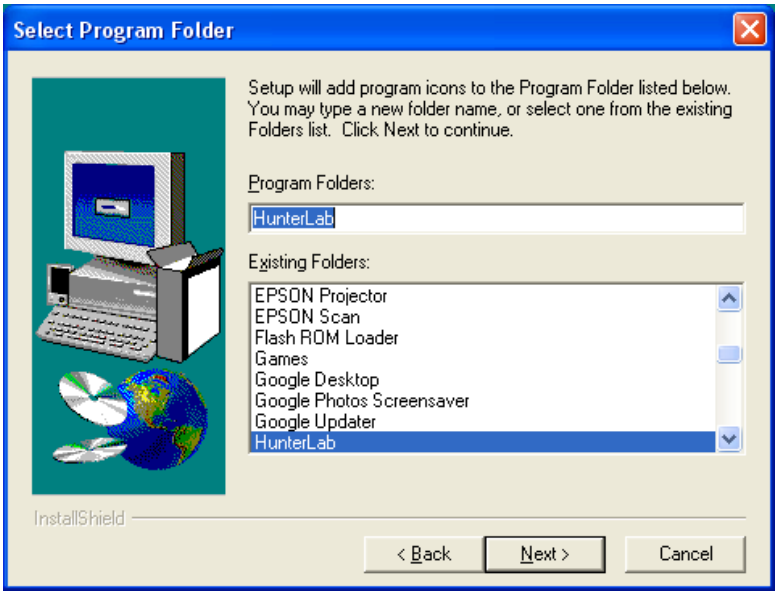
3) After a brief pause, the following screen will be shown.


Welcome
Welcome to the MiniScan EZ Utility Setup program. This program will install MiniScan EZ Utility on your computer.
It is strongly recommended that you exit all Windows programs before running this Setup program.
Click Cancel to quit Setup and then close any programs you have running. Click Next to continue with the Setup program.
WARNING: This program is protected by copyright law and international treaties.
Unauthorized reproduction or distribution of this program, or any portion of it, may result in severe civil and criminal penalties, and will be prosecuted to the maximum extent possible under law.
InstallShield
< Back
Next >
Cancel

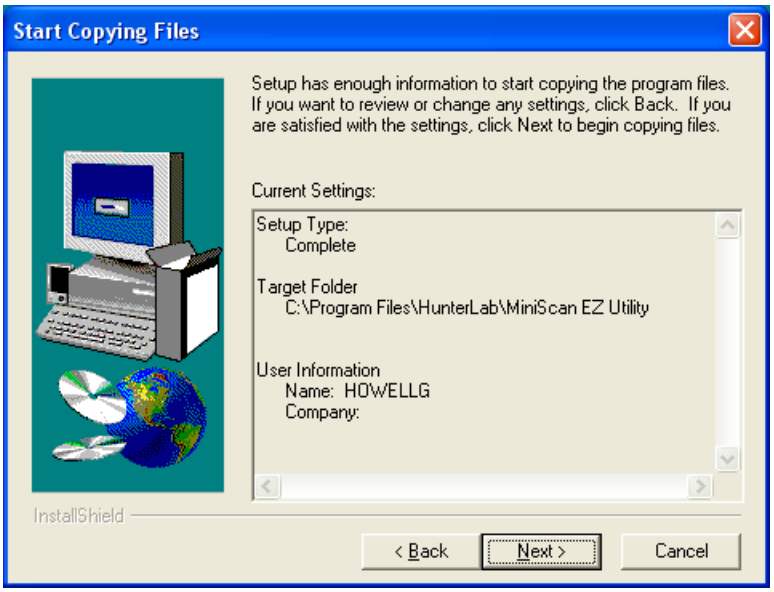
4) Read the information provided, exit any programs currently running, and press Next to continue to the next Installation screen.


Choose Destination Location
Setup will install MiniScan EZ Utility in the following directory.
To install to this directory, click Next.
To install to a different directory, click Browse and select another directory.
You can choose not to install MiniScan EZ Utility by clicking Cancel to exit Setup.
Destination Directory
C:\...\HunterLab\MiniScan EZ Utility
Browse...
InstallShield
< Back
Next >
Cancel

5) This screen allows you to choose the drive and directory to which all program files will be installed. It is recommended that the default drive and directory shown be used, but you may use any drive and directory desired. When the desired directory is shown in the Destination Directory box, press Next to continue to the next screen.

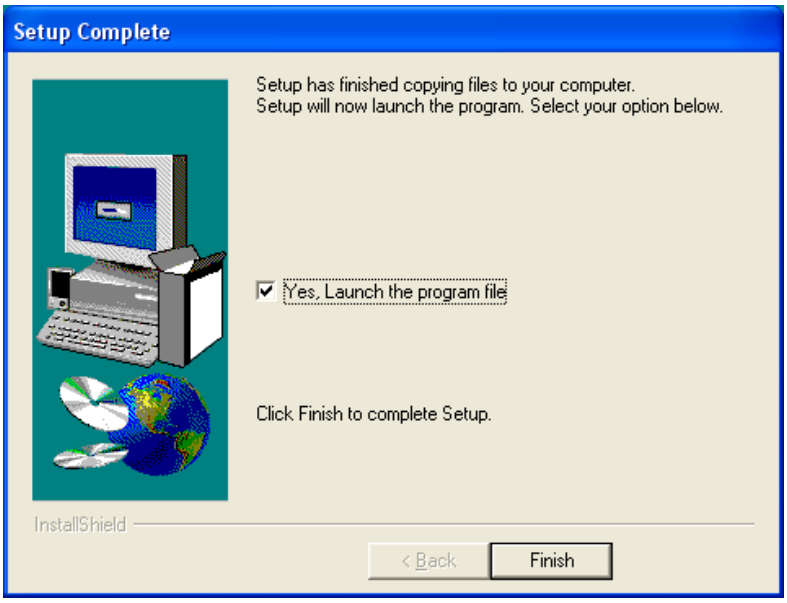


6) You are shown the folder in which the software will be placed. You may choose another folder from the list or type a new folder name into the box if desired. Then click **Next.**


Start Copying Files
Setup has enough information to start copying the program files. If you want to review or change any settings, click Back. If you are satisfied with the settings, click Next to begin copying files.
Current Settings:
Setup Type:
Complete
Target Folder
C:\Program Files\HunterLab\MiniScan EZ Utility
User Information
Name: HOWELLG
Company:
InstallShield
< Back
Next >
Cancel

7) You are shown a summary of the current installation settings. Click **Next** to accept these settings and then the needed files will be installed onto your system. A progress indicator will be shown.

8) The following screen will be shown when the installation is complete. If you wish to open the software right now, click the box next to "Yes, Launch the program file" and then click **Finish**. Otherwise, simply click **Finish** to Exit the installation program.


Setup Complete
Setup has finished copying files to your computer.
Setup will now launch the program. Select your option below.
Yes, Launch the program file
Click Finish to complete Setup.
InstallShield
< Back
Finish

Operation

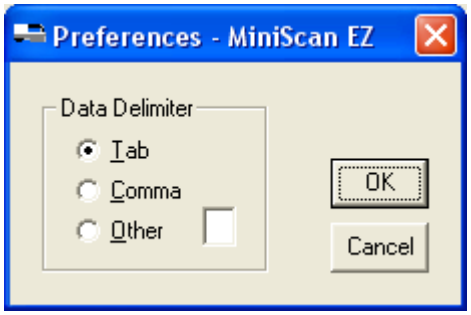
First connect the MiniScan EZ to the computer as described in the "Introduction to Your MiniScan EZ" chapter. Make sure that the MiniScan EZ is turned on and the USB cable is attached to the computer.

Note: The Utility Software is intended for use ONLY with the MiniScan EZ model. If you attempt to use the software with an older model MiniScan, the following message will result.

The File Menu

The File menu allows the following actions:

- **Preference**, which show the following screen where you can set your preferences for running the program. Select Tab or Comma delimiter or select Other and type the delimiter in the box to the right. Then select OK.



- Exit, which exits the Utility Software program.

The Sensor Menu

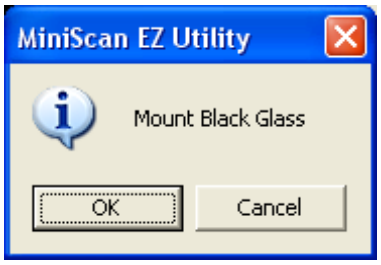
The **Sensor** menu allows the following actions:

- **Archive Product Setups**, which archives the product setups that are stored in the MiniScan EZ to a user selectable folder on the computer. Enter a name for the archive and select OK to begin downloading all Product Setups from the MiniScan EZ to the selected location.
- **Restore Product Setups**, which restores product setups back to the MiniScan EZ that were previously archived on the computer. Select a previously stored archive and press OK to load the setups into the MiniScan EZ
- **Identification**, which displays the firmware version, serial number, time and date of last standardization, and the number of samples stored in the data log.
- **Set Date and Time**, which allows the user to synchronize the MiniScan EZ time and date with the computer time and date.

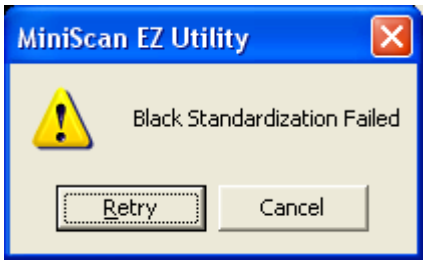
The Measure Menu

The **Measure** Menu allows the following actions:

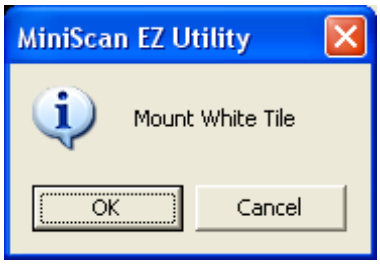
- **Standardize**, which yields the following prompts that step the user through the standardization process.



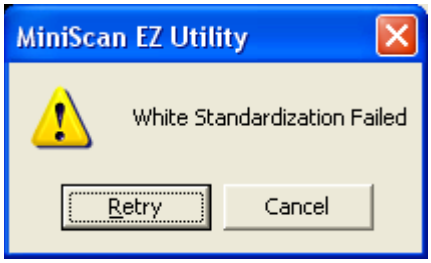
Note: If the black tile count is too high the following error will appear. Clean the black tile and try again.



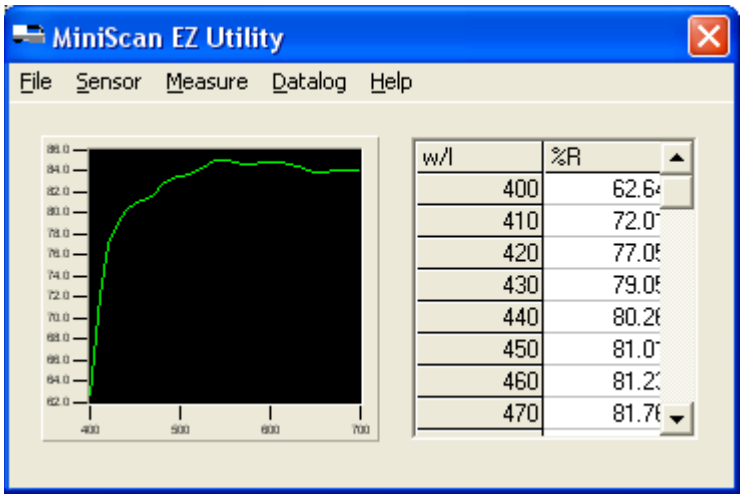
After an acceptable reading of the black tile, follow the prompts to read the white tile.



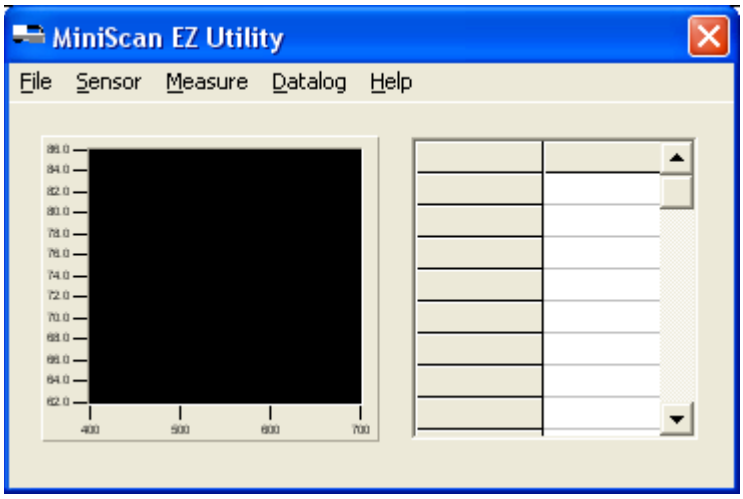
Note: If the white tile count is too low, the following error will appear. Clean the white tile and try again.



- **Sample**, which causes a sample to be read. A specular graph and reflectance table will be displayed for the sample that is read in a fashion similar to that shown below.



- **Clear**, removes any previously read sample data from the screen as shown below.



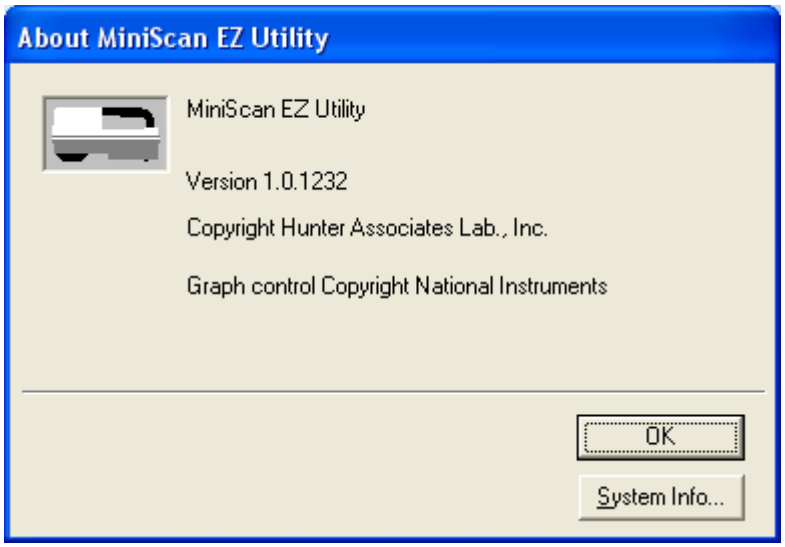
The Datalog Menu

The **Datalog** Menu allows the following actions:

- **Capture**, which causes the data stored in the instrument's datalog to be copied to a file. Selecting Capture will prompt the user for a name and location in which to store the datalog.
- **Clear**, which clears the instrument's datalog. A dialog box will appear to verify that the user wants to clear the datalog. Select "Yes" to clear the datalog or "No" to abort the selection.

The Help Menu

One item is available in the **Help** Menu, **About**, which causes the version and copyright information for the software to be displayed. You may select "OK" to return to the main menu or System Info for more information about the computer.



Keyboard Shortcuts

Some functions of the software may be accessed by using the computer keyboard. These shortcuts are detailed below:

Standardize F1

Sample F2

In sddition, the Utility Software menus may be opened using the Alt plus the first letter of the menu name and then the desired menu command may be selected by typing the underlined letter in the name of the command. These shortcuts are outlined below.

Open File Menu Alt + f

Open Sensor Menu Alt + s

Open Measure Menu Alt + m

Open Datalog Menu Alt + d

Open Help Menu Alt + h

Comands from an open File menu:

Preferences p

- Tab Alt + t
- Coma Alt + c
- Other Alt + o

Exit x

Commands from an open Sensor menu

Archive Product Setups	a
Restore Product Setups	r
Identification	i
Set Date and Time	d

Comands from an open Measure menu

Standardize	t
Sample	a
Clear	c

Comands from an open Datalog Menu

Capture	e
Clear	c

Comands from an open Help menu

About	a

Index

420-nm UV filter assembly 1-14
45/0 fiber package adapter 1-14
45/0 LAV nose cone with glass 1-14
45/0 LAV nose cone with polycarbonate 1-14
457B 9-8
457-nm brightness 9-8
A 9-3
About your instrument 1-19
Absolute color scales 9-1
Absolute display 2-15
Absolute indices 9-8
Accessories 1-3
Archiving measurements 1-10
Archiving product setups 1-9
Automatically generating tolerances 4-15
Autosave 2-5
Autosearch 2-7, 2-20
Average 2-7, 2-13
Averaging 2-13, 3-8
Backlight 2-3
Bar code reader 1-6, 3-6, 3-10
Basics of MiniScan EZ operation 1-16
Batteries 1-3, 6-1
Black glass 1-3
Brightness 9-8, 9-9, 9-11
Broken instruments 8-2
Button pad 1-16
C 9-3
Calibrated tile 1-3
Calibration cylinder 1-3
Certificate of traceability 1-3
Chroma difference 9-14
Chromaticity difference 9-14
CIE 1976 L*a*b* 9-3

CIE chromaticity coordinates 9-1
CIE L*C*h 9-4
CIE tristimulus values 9-1
Cleaning the MiniScan EZ 6-3
Clone all setups 2-24
CMC autotolerancing 9-15
CMC 2-18, 4-15
Color diff 2-7
Color index 2-17
Color plot display 2-16
Color scale 2-16
Color scales 9-1, 9-6
Colorant strength 4-40, 9-14
Contrast 2-4
Copyrights and trademarks ..... Front of user's guide
d457B 9-12
D50 9-3
D55 9-3
D65 9-3
D75 9-3
Damaged instruments 8-2
Date/time 2-8
dC chromaticity difference 9-14
dC* chroma difference 9-14
dE total color difference 9-14
dE* total color difference 9-14
dEc 9-15
Declaration of conformity 7-6
Delete all readings 3-12
Diagnostics CD 1-4
Diagnostics menu 1-17
Diagnostics 6-6
Diff plot display 2-16
Difference color scales 9-6
Difference display 2-15
Difference indices 9-12
Directional samples 5-4
Display dim 2-4
Display off 2-4

Display settings 2-3
Display 2-14
dL*da*db* 9-7
dL*dC*dH* 9-7
dLdadb 9-6
dTint 9-12
Dust cover 1-3
dWIE 9-12
dXdYdZ 9-6
dY brightness 9-12
dYdxdy 9-6
dYID 9-12
dYIE 9-12
dZ% 9-13
EasyMatch QC software 1-15
External printer 1-5
F11 9-3
F2 9-3
F7 9-3
Fiber package adapter 1-13
File Import Menu 1-10
Filter by setup ▸ 3-14
Geometry 1-2
Global options 2-2
Gray change 9-17
Gray stain 9-20
Green check tile 1-3
Green tile check 6-7
GSC 9-17
GSS 9-20
Hitch standard 2-12, 4-10
Hunter L, a, b 9-2
Ill/obs 2-16
Illumination 7-3
Incorrect shipment 8-3
Index 2-17
Indices 9-14
Installation 1-22
Instrument performance 7-5

Instrument repair 8-1
Instrument replacement 8-1
Keyboard 1-5
L*a*b* 9-3
L*C*h 9-4
Lab 9-2
Lamp 6-5
Language 2-2
LCD display 1-10
Lessons 4-1
Light trap 1-3
Main menu 1-17
Maintaining the instrument standards 6-4
Maintaining the MiniScan EZ 6-1
Measurement values 9-1
Menus 1-17
Metamerism index 4-20, 9-21
MI 9-21
Model 1-2
Multiple color scales 4-3
Multiple display types 4-3
Name 2-11
NIST traceable 1-3
Non-opaque samples 5-4
Nose cone with glass 1-14
Nose cone with polycarbonate 1-14
Numeric standard 2-12
Opacity 4-26, 9-25
Operating conditions 7-1
Operation 1-16
Opponent color scales 9-2
Options 1-5, 2-1
Other indices 9-14
Packing instrument 8-5
Paper brightness 9-11
Performance 7-5
Physical characteristics 7-2
Physical standard 2-12
Power 7-4

Preparing samples 5-2
Print all readings 3-13
Print all setups 2-21
Print one setup 2-22
Printer 1-5
Problems 8-1
Product setups 2-1, 2-10
Product standard 1-20
Prompts 1-17
Questions 8-1
Reading 3-5
Rechargeable batteries 1-3
Recharging batteries 6-1
Regulatory notice 7-6
Repairs 8-5
Replacing the batteries 6-1
Replacing the lamp 6-5
Reset all setups 2-22
Returns 8-5
Safety notes ..... Front of user's guide
Sample preparation 5-1
Sample presentation 5-1, 5-3
Sample 1-14
Saved readings menu 1-11
Saved readings 3-12
Screen angle 2-3
Searching 4-30
Selecting samples 5-1
Setup maintenance 2-21
Setup name 2-11
Setups locked? 2-5
Setups 2-1
Shade numbering 4-46
Shade number 9-21
Shade sort 2-18
Shipment shortage 8-3
Shipping claims 8-2
Shipping instrument 8-5
Signal levels 6-8

Skein holder 1-13
SMA 9-14
Specifications 7-1
Spectral data display 2-15
Spectral difference display 2-15
Spectral plot display 2-15
SSN 9-21
Standard search 4-30
Standard values 2-19
Standard 1-14, 2-11
Standard-A to mini-A USB adapter 1-6
Standardizing 3-1
Standards 6-4
Stdz interval 2-6
SW 9-15
System power 7-4
Terminology 1-14
Testing MiniScan EZ 6-1
Thumb drive information 1-8
Tile data sheet 1-3
Tint ASTM E313 9-8
Tint 9-8
Tolerances 1-14, 2-19, 4-15
Total color difference 9-14
Transferring measurements 1-11
Transferring product setups 1-11
Translucent samples 5-5
USB adapter 1-6
USB cable 1-3
USB Mass Storage Device 1-7
Using colorant strength 4-40
Using shade numbering 4-46
Utility software ..... 1-4, Appendix A
UV filter assembly 1-14
View saved readings 3-13
Viewing area 1-2
Viewing 7-3
Views 2-13
Warranty 8-1

Wet sample holder assembly....1-8
When you need assistance....8-7
White calibrated tile....1-3
White tile replacement....1-12
White repeatability....6-6
Whiteness index E313....9-9
WIE....9-9
Working standard....2-12
XYZ....9-1
Y brightness....9-9
Y....9-9
Yellowness index ASTM D1925....9-10
Yellowness index ASTM E313....9-10
YI D1925....9-10
YI E313....9-10
YID....9-10
YIE....9-10
Yxy....9-1
Z%....9-11